WIK-Consult • Revised Final Report

Study for the Australian Competition & Consumer Commission

Benchmarks for the Cost of the Mobile Termination Access Service in Australia

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0 Executive summary

1. We have been commissioned by the Australian Competition & Consumer Commission (ACCC) to carry out a study with the following (abbreviated) terms of reference:

   - Determine the cost of voice termination on mobile networks in Australia, using as basis corresponding benchmarks from cost models used in other jurisdictions
   - Provide advice on setting the SMS termination rate relative to the mobile voice termination rate using a conversion factor

   We report here the results of our study.

0.1 Benchmarks for the cost of voice termination

2. A requirement was that the cost models from which the benchmarks are obtained apply the TSLRIC+ or a comparable cost standard. A further requirement was that the benchmarks for the cost of voice termination be adjusted for country specific factors (parameters) that may impact the cost of providing this service in Australia. This required information regarding such parameters from the Australian operators. The ACCC obtained these parameter values the averages of which were considered to be applicable to the hypothetical efficient operator to which the results of the study are to apply. By relating the benchmarks and their underlying parameters to the corresponding averages of the three Australian operators, representing the hypothetical efficient operator, it is assumed that that operator has a market share of 33 %.

3. The ACCC suggested the following factors that may impact the costs of the mobile termination services:

   - Currency conversion
   - Geographic terrain
   - Population density
   - Network usage
   - Spectrum allocation
   - Mobile network technology
   - Scope of service offered (including 4G services)

   We removed from this list the factor “Geographic terrain”, because there is no robust international standard against which to assess country differences, and the effect would in any case be expected to be small; the factor “Population density”, because its effect is also covered by the factor “Network usage”; the factor “Spectrum allocation”, since differences in the availability of spectrum do not affect the benchmarks for the cost of termination; and the factor “Scope of service offered (including 4G services)”, since its effect is also covered by the factor “Mobile network technology”.

4. We added the following three factors:

   - Level of the WACC
   - Cost of spectrum
   - Higher cost of links in the backhaul network

   The factors “WACC” and “Cost of spectrum” are added, because they vary substantially between the models and, further, their averages differ substantially from the levels applicable in Australia. They therefore account for correspondingly large differences in the calculated costs. The factor “Higher cost of links in the backhaul network” has been included for this revised version of the report on account of criticisms and suggestions in operators’ submissions to WIK’s Final Report of 15 April 2015 and further advice by the ACCC.

5. Cost models from the following countries could be identified and were found suitable for the study:

   - Denmark
   - Mexico
   - the Netherlands
   - Norway
   - Portugal
   - Romania
   - Spain
   - Sweden
   - the United Kingdom

   A number of models could not be used, because they were either not populated or were populated with dummy values of the parameters. Further, while in respect of a number of countries it is known that their regulators use models, these could not be used here as they are not in the public domain

6. The first task consisted in converting the benchmarks expressed in local currencies into AU currency. This involved already the first adjustment, as a part of each local currency benchmark was converted on the basis of the relevant exchange rate adjusted for the difference in the purchasing power parity (PPP) between the benchmark country and Australia, given that the price level in Australia, when expressed at the nominal exchange rate, is one of the higher ones in the world. Further, we used the 10 year average of the nominal exchange rates, since it evens

out deviations of the exchange rates from their basic values that are due to current world market conditions. Table 0-1 shows the benchmark values for voice termination for the year 2015, expressed in AU cents converted on a 50/50 basis at the nominal exchange rates and the exchange rates adjusted for PPP differences.

Table 0-1: Benchmarks converted into AU cents

Country	Benchmark converted into AU cents …	
	at 10 year average of nominal exchange rate	on 50/50 basis of straight exchange rate and PPP adjusted exchange rate
Denmark	1.660	1.779
Mexico	1.947	3.569
Netherlands	2.786	3.420
Norway	3.137	3.137
Portugal	3.101	4.651
Romania	1.762	3.699
Spain	2.141	2.973
Sweden	1.989	2.132
UK	1.912	2.346
Average:	2.270	3.078

7. The other adjustments were carried out in the following order:

- Step 1 of adjusting for local spectrum fees: Elimination of the spectrum fees from the benchmark figures; spectrum fees applicable to the benchmark to reflect those in Australia are added as a last step
- Differences in the use of 2G and 3G network technology
- Differences in the WACC
- Differences in network usage
- Differences in the cost of links in the backhaul network
- Step 2 of adjusting for spectrum fees: Adding spectrums fees relevant for Australia

The averages of the benchmarks after each adjustment are shown in Table 0-2.

Table 0-2: Effects of adjustments on average of benchmarks

Factor for which adjustment is carried out	Average change	Benchmark after adjustment
	AU cents	
Average value of benchmarks after conversion to AU cents, taking account of differences in PPP		3.078
Average adjustments		
- Spectrum fees – step 1	-0.263	2.815
- Network technology	-0.991	1.824
- WACC	-0.123	1.701
- Network usage	-0.118	1.583
- Cost due to greater distances in backhaul network	+0.047	1,630
- Spectrum fees – step 2	+0.018	1.648
Average of benchmarks after all adjustments		1.648

8. As shown in Table 0-2, after performing all adjustments, the average of the benchmarks amounts to 1.648 AU cents. We briefly comment on the adjustments in the order of the magnitude of their impact:

- Differences in the network technologies used have the largest impact. This is due to the fact that in Australia 94 % of voice is carried over 3G whereas in the benchmark models this share averages to only 52 % and an average share of 48 % of voice is still carried over the much less efficient 2G technology. When corrected for this, the benchmark values decrease on average by 0.991 AU cents.

- Spectrum fees make up on average 7.8 % of the benchmarks; for Australia only a 1 % share of the resulting cost estimate is justified. On balance, this decreases the average of the benchmarks by 0.245 AU cents (the balance of minus 0.263 AU cents and plus 0.018 AU cents).

- The WACC values applied in the benchmark models averages to a value of 9.4 % compared to a value of 5.89 % relevant for Australia. Corresponding adjustments decrease the average of the benchmarks by 0.123 AU cents.

- Network usage per site is in Australia almost three times higher than on average in the benchmark models, most of that, however, due to data traffic. The cost of voice traffic is affected by this through a smaller share of fixed infrastructure cost, which decreases the average of the benchmarks by 0.118 AU cents.

- In accordance with the suggestion from one of the operators, an adjustment for the higher cost due to greater backhaul distances in the Australian networks is applied. At a rate of 3 % of the cost of termination, this increases the average of the benchmarks by 0.047 AU cents.

9. As candidates for the benchmark of the cost of voice termination for the hypothetical efficient operator in Australia in the year 2015, we considered three statistics: the average (mean), the mean with the upper and lower extreme values removed, and the median of the adjusted model benchmarks. Their values are shown in Table 0-3. The median and the mean with extremes values removed are usually considered to be the statistics that are less affected by possible biases.

Table 0-3: Means and median of adjusted benchmarks

Statistic	Value (AU cents)
Mean (average)	1.65
Mean with extreme values removed	1.68
Median	1.65

We selected the mean with extreme values removed, since it seemed appropriate, of the two preferable statistics to use the more conservative one and thus disregard the median.

10. Operators in Australia are expected to start offering voice service on the basis of 4G technology during the upcoming regulatory period. Therefore, for the forecast values for the years 2016 through 2020, this has to be taken into account. The forecasts were derived from two benchmark models which included the provision of voice service on the basis of this technology during the regulatory period. They were obtained both directly from these two benchmark models as well as on the basis of the cost relationships between 4G and 3G technology and the assumed share of 4G technology used in 2020 for voice service in these models.

11. Our recommendation regarding the cost range for voice termination for the years 2015 through 2020 is based on the forecasts discussed above and the observed standard deviations of +/- 16 % around the 2015 mean value with extremes removed. These recommended cost ranges are shown in Table 0-4.

Table 0-4: Recommended cost ranges for the termination of voice for the years 2015 – 2020

Year	Limit of lower range	Benchmark values for the years 2015 - 2020	Limit of upper range
	AU cents		
2015	1.41	1.68	1.95
2016	1.34	1.59	1.84
2017	1.26	1.50	1.74
2018	1.18	1.41	1.64
2019	1.11	1.32	1.53
2020	1.04	1.23	1.44

0.2 Derivation of the cost of terminating SMS

12. In relation to the second part of the terms of reference, we showed, first, that the cost of an SMS message consists of two components, (a) the cost of conveyance over the network, i.e. the part of the network that is used in common by voice, SMS and data, and (b) the cost of equipment dedicated specifically to the SMS service, i.e. the SMS centres. It is in respect of (a) relative to which we checked whether it can be set relative to the cost of mobile voice termination using a conversion factor

13. Given the above, we showed that the cost of conveyance of an SMS stands in a fixed relationship to that of carrying one minute of voice. The corresponding conversion factor is 0.00121, or that fraction of one minute of network usage needed for conveying one SMS. The corresponding cost of conveyance for one SMS is therefore this conversion factor times the per minute cost of 1.68 AU cents for voice, which for 2015 results in 0.002 AU cents.

14. We next derived the costs of SMS centres used in the network of the Australian hypothetical efficient operator. This calculation was based on information from the benchmark models, on the level of the WACC as applicable to Australia, and on experience values from the WIK data bank for opex, common cost and the economic lifetimes of such SMS centres. Dividing the resulting annual cost by the number of SMS messages in Australia projected for 2015, we arrived at a cost per SMS of 0.026 cents.

15. Our advice to the ACCC regarding the cost of terminating an SMS is to base it, as just discussed, on the sum of the two cost components for (a) conveyance and (b) SMS centres. For 2015 this calculation leads to a cost of termination of 0.028 AU cents per SMS.

1 Description of the consultancy

The Australian Competition & Consumer Commission (ACCC) has commissioned WIK-Consult (1) to provide an estimate of the costs of providing mobile voice termination in Australia by benchmarking against the costs of providing mobile terminations services in international markets, and (2) to provide advice on setting SMS termination rates relative to mobile voice termination rates.

1.1 Terms of reference

In the Order for Services it is specified that the required services are to be provided in accordance with the following terms of reference (ToR):

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A. The consultant will conduct an international benchmarking exercise to assess / estimate the cost of providing the mobile voice termination service in Australia. This requires the consultant to benchmark against cost of providing mobile termination services in international markets from the application of a cost model.

   Specifics of the service required:

   1. Selection criteria for the benchmark set

      The benchmark set should be selected based on the following selection criteria:

      a. The benchmarks used should be the outputs of cost models that are based on TSLRIC+ cost concept.

         The benchmark set should include TSLRIC+ rates calculated or published by international regulators even if they have adopted a pure LRIC methodology to determine the regulated termination rates. If feasible, the consultant may construct TSLRIC+ rates from pure LRIC models to add to the benchmark set.

      b. Benchmarking against costs rather than regulated mobile termination rates

         The ACCC considers that consultant should benchmark against the costs of providing mobile termination services in international jurisdictions, rather than the regulated termination rates ultimately adopted in regulatory decisions.

      If the consultant proposes additional selection criteria in deciding on the benchmark set, clear reasons should be provided.

2. Adjustment process for the benchmarks

   The consultant shall make appropriate adjustments to the outputs from international cost models to take into account country specific factors that may impact the costs of providing termination services in Australia. Such factors may potentially include:

   - Currency conversion
   - Geographic terrain
   - Population density
   - Network usage
   - Spectrum allocation
   - Mobile network technology
   - Scope of service offered (including 4G services)

   The consultant may make adjustments to take into account any of these or other factors if it considers it feasible and necessary to do so. All adjustments must be clearly explained with reasons.

3. Estimated costs of the MTAS in Australia

   The consultant will provide advice and recommendations on a cost range that it considers reflects the estimated costs of providing the mobile voice termination service in Australia.

B. The consultant will provide advice on setting the SMS termination rate relative to the mobile voice termination rate.

   The ACCC is contemplating setting the SMS termination rate relative to the mobile voice termination rate based on the number of SMS that can be sent using the capacity for one minute of voice call (i.e. a conversion factor). The ACCC seeks advice from the consultant on the following issues:

   1. Whether this is a feasible approach to determine the regulated SMS termination rate.
   2. If it is a feasible approach, how should the ACCC determine the appropriate conversion factor to use.
   3. What adjustments should be made to refine a conversion factor solely based on the relative capacity requirements of voice and SMS services.

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WIK-Consult has implemented the ToR within the limits of the degrees of freedom provided by them. In Chapter 2, we will for the purpose of clarification provide comments on a number of aspects in the ToR, in particular also on some of the country specific factors, that may impact the costs of providing termination services.

This Revised Final Report describes the results of the study after taking into account the subsmissions of the Australian mobile operators[1] in response to WIK's Final Report of 15 April 2015 and further advises by the ACCC. Whenever the approach or values of parameters are different from those used in the earlier report, the text will point this out. Also, given that this is a revised report incorporating additional reflections on the various issues, the ductus of the text has undergone some changes in the process of the revision.

1.2 Overview over steps for carrying out the consultancy

In Chapter 2, as mentioned in the preceding section, we provide clarifications and interpretations regarding some terms in the ToR, in particular regarding some of the factors expected to have an effect on the costs of terminating services. Chapter 3 covers the process by which the applicable models were selected. In Chapter 4 we describe the adjustments made to the benchmarks discussing each time the approach used. Chapter 5 in turn covers the derivation of the cost of terminating SMS based on the cost for voice termination and taking into account the cost of dedicated SMS centres. Finally, Chapter 6 provides advice on the range of costs from which the ACCC may select the value for the MTAS rates.

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1 See Optus (2015); Telstra (2015), Vodafone (2015), and Network Strategies (2015) on behalf of Telstra.

2 Commentary on the criteria specified in the ToR

Three types of comments are provided, (a) clarifications as to what particular terms mean and imply, (b) critical discussion of some country specific factors in the ACCC's list, and (c) presentation of two additional country specific factors that are proposed by WIK-Consult.

2.1 Use of the term "Total Service Long-Run Incremental Cost Plus (TSLRIC+)"

The ToR specify that the benchmarks to be used should be determined on the basis of the TSLRIC+ cost standard. The ACCC had decided on this methodology[2] after considering the submissions to its discussion paper of August 2014[3] with which it had initiated a consultation with stakeholders on how it should approach the pricing of the MTAS.

This TSLRIC+ standard is characterised by the fact that (a) the total costs incurred to provide services are distributed to the different services on the basis of a matrix of factors reflecting the intensity with which these services use the various network elements (the routing matrix), (b) there is a mark-up on the so-derived cost of each of the services to cover organisational common cost and (c) that it covers all costs incurred for providing the service. This cost standard, referred to in Australia as TSLRIC+, is applied in other jurisdictions in Europe and elsewhere under different designations, either as "Long-Run Average Incremental Cost (LRAIC)", "Long-Run Incremental Cost Plus (LRIC+)" or "Long-Run Average Incremental Cost Plus (LRAIC+), where through the "A" it is emphasised that it is an average cost, averaged also over common cost, and the "+" indicates that also organisational common cost in addition to network common cost are included. It is here the matter of differences in terminology only and not of substance. In this consultancy, whenever a model that is otherwise applicable uses one of these standards, and it is assured that total costs are allocated using a routing matrix and there is a mark-up for organisational common cost so that all cost are covered, this is considered to be consistent with the TSLRIC+ approach as required by the ToR.

2.2 The requirement to use benchmarks

The costs of the MTAS are to be determined on the basis of benchmarks, where the benchmarks are for costs determined according to the TSLRIC+ (or comparable) cost standard and used by the NRA of the benchmark country.

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2 See Australian Competition & Consumer Commission (2015):

3 Australian Competition & Consumer Commission (2014.

It is generally recognised that benchmarks cannot be as precise as estimates that are based on an own model and that the use of benchmarks entails greater margins of error. Benchmarks may deviate from an appropriate estimate of the variable of interest due to two types of influences. The one is systematic in the sense that it derives from different values of important determinants applied in the models, the other is unsystematic or random in the sense that it derives from peculiarities of the concrete modelling approaches.

In the case of the unsystematic type of deviation, the components of the benchmark set may differ from one another due to reasons that are particular to the backgrounds from which the benchmarks come. For example, in our context, differences between the costs of termination found in the benchmark models may have come about, because the NRAs determining the costs have different concerns regarding the performance of mobile operators; they may be more concerned about users, more about producers, what politicians say or the European Commission wants them to do. Or, the institutional set-up requires them to heed more the claims of the one or the other stakeholder. Or, the levels of efficiency modelled by the consultants selected to construct the models may differ that would cause the results to be higher or lower than otherwise. Or, either too conservative or too optimistic assumptions were used in the parameterisation of the models. There is, however, a saving feature in this respect which lies in the statistical nature of the approach. Through the use of a sufficiently large number of observations there is the reasonable expectation that these unsystematic differences in the results are at least in part washed out. Despite this, however, there remains a risk of bias that will be taken up further below.

As regards the systematic differences, these are differences in results due to known differences in cost-driving parameter values. One such important difference may be that in the one country, voice service is carried to X % over 2G technology and to (1-X) % over 3G, while in Australia the shares are Y % and (1-Y) %. In this case adjustments, as called for in the ToR, are possible whereby the benchmark value is changed in the appropriate direction on the basis of a known respective elasticity with which the cost of termination reacts to the percentage changes in technology use. Ideally, one would be able to compensate for all such systematic deviations, which, however, is not possible so that the focus is usually – as also in this study – on the most important ones.

Given the above discussion, the assumption is that, once the impact of country specific factors is accounted for, the correspondingly adjusted benchmarks, appropriately averaged, provide the basis for a largely unbiased estimate of the costs of the termination services in Australia. At the same time it is recognised that there will remain a margin of error that is unavoidable with any estimate.

In particular, if there are outliers in either direction there may then also remain an error or rather bias in this direction. Actually, there is more of a risk of an upward bias than vice versa. The reason is that the values of the benchmarks are limited in the downward but not in the upward direction. If for some of the reasons mentioned above, a benchmark value is biased downward, this downward bias will be constrained by the fact that the limit is zero and the benchmark value must remain above that limit to a credible extent. If in contrast, a benchmark value is biased upward, there is no such natural limit, and the bias may well be larger than it could be in the downward direction.

Margins of error and possible remaining biases are part of statistical reality and must be faced by the regulator when making its final decision. Given that regulators are in the obligation to keep regulated operators whole, this circumstance usually leads to accepting a slight upward drift in the estimate to compensate for the chance that the error may be on the negative side. The mechanism is usually being referred to as “being conservative”. While this is to the benefit of the regulated operators, demanders of the regulated service may object that this is to their unjustified disadvantage. There is, however, a justification in the sense that this is the part of the cost of regulation that demanders have to bear, their overall benefit being that they will enjoy regulated rates that generally are substantially lower than they would be without regulation. We make this comment, since there will be instances where we will also face situations where it appears to be appropriate to “be conservative” in this sense. We will point this out when this is the case.

The approach regarding the adjustments for systematic differences in the bechmarks discussed above is summarized int the following methodological note.

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Methodological note:

The approach used in this study for accounting for differences in the country specific factors will be based on WIK-Consult’s knowledge of the cost relationships in mobile networks and its extensive experience in working with corresponding network and cost models. In applying this approach, parameter values will always be selected that reflect both this understanding and at the same time an acute awareness of the uncertainty that necessarily surrounds such parameter values. As a result, parameter values will tend to be selected that would rather lead to conservative than progressive results.

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The fact that the benchmarks will be subject to adjustments for country specific factors of sufficient importance, implies the obligation to include all benchmark models that fulfil the criteria stated earlier. Given that these adjustments are being applied, there would be no reason, except in obvious cases, to exclude a benchmark model because of the existence of country specific factors that supposedly would not make the country eligible. Proceeding otherwise would open the door to argue for the exclusion of some benchmark countries due to other irrelevant concerns and not be in the spirit of an unbiased approach.

2.3 What are the benchmarks for?

In the preceding section we discussed properties of the benchmarks that will be found in the benchmark models. They are (a) the benchmarks on which the adjustments are to be affected. The result of the adjustments will also be (b) benchmarks, i.e. the benchmarks for the costs of providing MTAS in Australia. This means that in the course of the study, the expression “benchmark” will be used with different connotations. In the case of (a), “benchmarks” will be the observations from the benchmark models of which there are always as many as there are models. In case (b), “benchmarks” are the result of the study and stand for the estimates of the cost of the MTAS in Australia. It will be clear each time from the context, what connotation of “benchmark” is being referred to.

In the preceding paragraph it was said that the benchmark in the sense of (b) is for the cost of providing MTAS in Australia. As the ACCC advised us, there will not be three individual cost benchmarks, one for each of the three actual operators in Australia. This implies that the resulting benchmark will be for a hypothetical market situation in which a hypothetical operator has a market share of one third. Given that the cost benchmark will correspond to the TSLRIC standard, which is the cost of an efficient operator, It is also assumed that this hypothetical operator will be an efficient operator, as is also assumed to be the case for the operators represented in the benchmark models.

2.4 The requirement to carry out adjustments

When adjustments for country specific factors are to be carried out, these adjustments must correct the outcomes of the benchmark models for the impact of the differences in cost driving country specific factors (parameters), holding (a) in the benchmark models and (b) in Australia. This implies, that the values of the corresponding parameters holding for Australia must be known. For this reason, WIK-Consult requested the ACCC to obtain this information from the operators, which was then provided. When discussing the adjustments in Chapter 4, the parameters to which this requirement applies will be apparent and their values for Australia will then be indicated.

One important aspect in this context is that the parameter values applicable to Australia will be averages of the values obtained from the three actual operators. These averages are considered to be the parameter values relevant for the assumed hypothetical efficient operator for whicht the benchmark cost for termination is to be derived, as discussed in the preceding section.

2.5 Country specific factor “Geographic terrain”

In the version of this report dated 15 April 2015 (the previous version), we made adjustments to the benchmarks based on the degrees of differences in geographical profiles of the benchmark countries compared to that of Australia. It turned out that the averaged overall adjustment was very small, primarily because the observed differences in the benchmark countries’ geographical profiles mostly cancelled each other.

In the submissions of operators, this adjustment was criticized for not being based on a robust standard and leaving out other factors, for example the feature that Denmark is made up of many islands, that would also have to be picked up under this head. The thrust of these criticism was that it would be advisable to delete this adjustment. The ACCC concurred with this assessment, given that there is no internationally agreed standard for classifying terrain implying that the the adjustment would be somewhat subjective and uncertain. We have accepted this criticism and will not carry out any adjustment under this head.

2.6 Country specific factor “Population density”

This factor has been the subject of extended discussions in the Australian regulatory environment, with the strong implication that Australia’s low density has an upward impact on the cost. Those who refer to it appear to suggest that population may more or less be evenly distributed over the whole territory of Australia which would imply that there are many areas where demand is thin and therefore cell sites are coverage driven, which in turn implies that the number of users per cell site would be relatively low and therefore cost per unit of service high. This is an argument that without concrete information to verify it has the ring of plausibility.

Some doubt on the degree of plausibility is, however, already cast by the fact of Australia’s high rate of urbanisation. It is, with 89 %,[4] higher than that of most benchmark countries. This means that for 89 % of the population the notion that they live in low-density areas, where the cells of a mobile network have few users, does not hold. Still, it might be that the remaining 11 % of the population live so dispersed in Australia that this may entail a relatively large number of coverage driven cells with very few users and therefore high cost per unit of service. Again, this remains an argument in the abstract which may or may not be true.

In the current study, we are not restricted to arguing in the abstract, given that we are using concrete information from operational models that allow the comparison of network statistics from these models with actual statistics for Australia. We will come to those statistics shortly. First we highlight the difference between arguing in the abstract,

4 See World Bank (2015).

when concrete statistics are not available, and developing insights on the basis of concrete information.

Without doubt, Australia’s population density is extremely low and there are certainly areas that are served by base stations that are placed there to only provide coverage. And there may be proportionately more of these areas than in other countries. If everything else were equal, this would lead to higher cost per unit of service in Australia, especially given that the cost of access usually makes up between 60 % and 70 % of total cost. Everything else, however, may not be equal. Note, first, that the per-unit (per-minute) cost of radio access is arrived at by taking the total cost of all radio access networks (those that are coverage-driven as well as the other ones, i.e. those that are traffic-driven) and dividing that cost by the total volume of service. Note, second, that, although there may be quite a number of coverage-driven cells, it may also be that in the other cells volumes of traffic are so high that as a result cost per unit (cost per minute) is very low, which overall would more than compensate the upward effect due to coverage driven cells.

What in the preceding paragraph has been portrayed as a possibility is a fact based on information regarding Australian networks and the networks of the benchmark models. Table 2-1 provides two series of statistics, each time both for the Australian hypothetical network (averages taken over the three networks) and for the networks from the benchmark models:

(a) The average number of users served from one site;

(b) The average volume of traffic delivered over one site.

Comparing the statistics in the table, the following facts emerge: As far as the number of users served on average from one site is concerned (see column (2) of Table 2-1), the number for Australia is lower than that of only two of the benchmark models and is higher than that of the other seven. What does this mean? Even if there were relatively many coverage-driven cells in Australia with few users being served in them, this becomes irrelevant, given the large number of users served in the other sites. It is clear that the more users are served per site, the lower is the cost per unit of service, since the fixed cost of a site is spread over more and more users. Therefore, it follows already from this comparison that the cost of termination need not necessarily be higher in Australia due to low population density and the resulting prevalence of coverage-driven cells.

Table 2-1: Network usage in Australia and the models

(1)	(2)	(3)
Country	Number of users per site	Volume of traffic per site in GB
Australia	*1,344*	*15,569*
Denmark	607	9,944
Mexico	2,681	5,102
Netherlands	1,444	1,838
Norway	430	3,429
Portugal	1,089	4,441
Romania	729	1,323
Spain	1,013	6,014
Sweden	764	8,779
UK	1,078	8,990

Sources: ACCC regarding values for Australia.
Benchmark models for all other values, where the models for Denmark, Portugal, Sweden and the UK are more recent than the ones originally used (see discussion in Section 3).

This conclusion is confirmed by comparing the volumes of traffic that are shown on average to be delivered through one site (see column (3) of Table 2-1). Here, the figure for Australia is by far the highest, being more than one and half of the nearest one from the benchmark models, i.e. the one shown for Denmark. Again, since the higher the volume per site, the lower is the cost per unit of service, it follows from this comparison that the cost of termination will not be higher in Australia due to low population density.

One may wonder why the benchmark models show volumes of traffic per site that are so low in relation to that shown for Australia. A possible answer is that at the time of their construction, in one case three years back, the expectation of the high growth of data was not yet so prevalent so that rather pessimistic forecasts were used. This will have led to relatively high costs per unit of service given today's volumes of service, which will have to be taken into consideration when the corresponding adjustments are to be made in Section 4.3. The observations just made lead to the consideration that for the purposes of this study, it is the reality of the benchmark countries as represented in the models, which is to be compared with the actual reality in Australia, not that now actually prevailing in these countries, since the benchmarks taken from the models are determined by that "model reality".

2.7 Country specific factors “Mobile network technology” and “Scope of services offered (including 4G services)”

Under this head, first the roles of 4G technology and of 4G services are to be considered. Four of the benchmark models consider 4G services, but only two consider voice over 4G, and this only in the later periods covered by the model. We are advised by the ACCC that Australian operators report that besides offering data over 4G, they will start offering voice over 4G during the upcoming regulatory period. Given these circumstances, we will not adjust the benchmarks for any differences in the use of 4G technology for the provision of termination services for the year 2015. However, when projecting the development of the cost of termination over future years, we are going to factor in the anticipated effect of a forecast share of voice over 4G into this development (see Section 4.9).

In contrast to 4G, there is room for adjustment regarding the use of 2G and 3G technologies for conveying voice traffic. While in Australia a percentage of only about 6 % of voice is carried over 2G and the rest over the more efficient 3G technology, the models show higher degrees of use of 2G, ranging from 32 % to 71 %, and corresponding shares of 3G. Since 3G is substantially more efficient and therefore less costly than 2G, adjustments are to be carried out to account for the corresponding cost differences (see Section 4.3).

2.8 Country specific factor “Spectrum allocation”

In general, spectrum allocation may have an impact on the cost of providing services according to the relation of the size of the available spectrum to the volume of services to be delivered. If there is more spectrum in terms of bandwidth available then traffic driven cells can be larger which means fewer cells are needed which means that cost of hardware is saved and cost per unit of service is lower. Since we are here concerned with the cost of voice termination and SMS, we need to verify whether there are differences in spectrum availability for operators in Australia and the operators in the benchmark models that would warrant adjustments in the cost estimates for these services in the models. For this purpose we look at allocations of spectrum from those spectrum bands that are commonly used for voice and SMS, i.e. the 900 MHz and 1800 MHz bands for delivery over 2G technology and the 2100 MHz band for delivery over 3G technology.

These allocations are shown in Table 2-2.

Table 2-2: Spectrum allocations per operator in Australia and the benchmark models

(1)	(2)	(3)	(4)	(5)
Country	Spectrum band			Total spectrum
	900 MHz	1800 MHz	2100 MHz	
	MHz			
*Australia**	*8.3*	*21.7*	*20.0*	*50.0*
Denmark	8.8	18.8	15.0	42.6
Mexico**	5.0	21.7	-	26.7
Netherlands	11.6	18.2	20.0	49.8
Norway	11.0	8.4	15.0	34.4
Portugal***	8.0	20.0	20.0	48.0
Romania	10.0	10.0	15.0	35.0
Spain	10.2	22.3	21.0	53.5
Sweden	7.2	10.0	15.0	32.2
UK***	-	20.0	10.0	30.0

* Averages of allocations to the 3 Australian operators; the allocations for metropolitan areas are used; the 20 MHz shown for 2100 MHz are in the 2000 MHz band.
** Allocations in the 850 and 1900 MHz bands to be used in 2G.
*** The new models for Portugal and the UK show different spectrum allocations than the preceding ones.

We emphasize again that the spectrum allocations shown in Table 2-2 are for those spectrum bands that have commonly been used for voice and SMS. When spectrum in the bands below 900 MHZ and above 2100 MHz became available for mobile services, these were in general used for the new data services. Furthermore, we know that the 900 MHz and 1800 MHz bands, used in the past to a large extent for realizing voice and SMS over 2G technology, have with the decline of this technology been more and more deployed for the realization of services carried over both 3G and 4G technologies, i.e. the technologies that are more efficient than 2G. Therefore, with the shift of a larger and larger share of voice to 3G, any restriction due to limited availability of spectrum on the deployment of base stations for the realization of voice and SMS have been more and more relaxed.

Before this background, looking at the total available spectrum in column 5, it appears that each operator represented in Table 2-2, whether in Australia or any of the benchmark countries, appears to be liberally equipped with spectrum for the delivery of voice and SMS services. We note in particular large allocations in the 1800 MHZ band, which used to be needed when voice and SMS had to be delivered in traffic driven cells over 2G technology, and for the 2100 MHz band, which is used when voice and SMS are carried over the more efficient 3G technology. From this follows that spectrum for the delivery of voice and SMS services is for all these operators available in more than sufficiently large amounts and the degree of use of spectrum from these bands for these services is a result of management decisions that are taken according to the requirements of providing both voice/SMS services and data services over these bands. In other words, it is not the exogenously determined availability of spectrum that determines the use of particular amounts of spectrum for the one or other service, but these degrees of usage follow from operators' management decisions regarding how to best run their networks. From this follows that there would be no need to carry out adjustments to the benchmarks due to differential, exogenously determined, availabilities of spectrum.

2.9 Country specific factor "Higher cost of links in the backhaul network"

For this revised version of the resport, an additional country specific factor was taken up. This was decided on after scrutiny of operators' submissions and after discussion with the ACCC. Given the huge distances in Australia, the links between network nodes are necessarily longer than in countries where operators do not have to face these distances. This implies that *ceteris paribus* the costs of backhaul links are higher than in the other countries. These higher costs, due to the high network usage in Australia, are in part compensated by the possibility of using higher capacity transmission systems that on a per-km basis are less expensive than such systems of lower capacity. Nevertheless, there is the presumption that there is a cost differential that needs to be taken into account (see Section 4.5).

2.10 Country specific factor proposed by WIK "Level of the WACC"

The intensive discussions in many jurisdictions in Europe and elsewhere on the level of the WACC witness to the relevance of this factor. This is so because the WACC directly affects annualised capex which is one of the most important cost components of a telecommunications network. A higher level of the WACC means a higher level of cost, and of course vice versa for a lower level. The values of the WACC applied in the benchmark models vary between 4.6 % and 12.95 %, while we are advised by the ACCC that the one applicable in Australia is 5.89 %. From this follows that the level of the WACC is to be included as one of the country specific factors that may impact the costs of providing termination, and that also in respect of the WACC adjustments will have to be carried out (see Section 4.4).

2.11 Country specific factor proposed by WIK "Cost of spectrum"

Also in respect of the cost of spectrum, there have been intensive discussions in many jurisdictions regarding the share of that cost that should be recovered through regulated rates. The importance of spectrum fees becomes apparent when one considers that in the benchmarks they make up cost shares ranging from 0 % to 16 %. As will be shown in Section 4.7, the corresponding share for Australia is 1 %, from which follows again that adjustments will have to be carried out to make the benchmarks consistent with the level of spectrum fees in Australia.

3 Selection of models

The criteria for selecting the models have been that they have been used by the national regulatory authorities (NRAs) of the given countries to determine the cost of voice termination and that they are publicly available. In order to identify models that complied with this criterion, we carried out research on the websites of NRAs that were likely to have used such tools. This search was carried out in a methodical way as described below.

First we scrutinized the websites of NRAs of all OECD countries where the “calling party pays (CPP)“ principle is applied.[5] These are the countries the most likely to be similar to Australia in terms of economic development, types of networks and level and structure of demand. The countries next in line were the countries of the EU that were not members of the OECD. We then checked whether models were available from countries where we knew that the NRA uses a cost model. Here we disregarded the countries from the Caribbean (where cost models are being used), on the basis that the networks of these small island countries are too dissimilar to those in Australia. Finally, we searched the websites of the NRAs of the largest remaining countries which are applying CPP. This search we stopped after not identifying any available model after we had checked the ten largest countries of this remaining category. This was done on the realistic assumption that further search would not lead to the identification of any further useable model.

The above paragraph describes the search that led to the selection of benchmark models underlying the previous version of this report. Since then, as also pointed out in the submissions by the operators, more recent models have become available for the four countries Denmark, Portugal, Sweden and the UK. The analyses and results discussed in the present version of the report are based on the selection of benchmark models that has accordingly been updated.

The websites from which the models can be downloaded are shown in the appendix.

The benchmarks to be obtained from the models are the costs calculated on the basis of the TSLRIC or a comparable standard, even if the model was in the end used for another, e.g. the Pure LRIC, cost determination. The proviso for this was that the models had carried out the relevant calculations and also provided the information on the basis of the appropriate standard. Table 3-1 shows the list of countries for which models fulfilling the criteria could be identified. Besides the names of the countries, the table also shows the cost standard eventually applied by the NRA and the one also provided and used in this study.

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5 In countries in which the principle of “receiving party pays (RPP)” is applied, no regulation is needed and one would therefore find there no cost models.

Table 3-1: Selected benchmark countries

Country	Cost standard applied by the NRA	Standard also provided in the model and used here
Denmark	Pure LRIC	LRAIC+
Mexico	Pure LRIC	Plus LRAIC
Netherlands	Pure BULRIC*,§	Plus BULRAIC
Norway	Pure LRIC	LRIC+
Portugal	Pure LRIC	LRAIC+
Romania	Pure LRIC	LRAIC+
Spain	Pure LRIC	LRIC+
Sweden	Pure LRIC	LRAIC+
UK	Pure LRIC	LRIC+

* BULRIC ≡ bottom-up LRIC, i.e. LRIC determined on the basis of a bottom-up model.
§ A court later overturned the regulator's decision and required that a rate based on LRIC plus be applied..

The models for these countries are all of recent vintage, none is older than 3 years and all contain estimates for the year 2015. We also consider that a number of nine models is adequate to obtain a range of benchmarks that sufficiently closely encompass the appropriate estimate for Australia. We note here that the New Zealand Commerce Commission, in its report on whether the mobile termination access services should become designated or specified services, uses a benchmark set composed of one more country, but for which the relative range of values is larger than for the present data set.[6]

There are a number of countries in which the NRAs use models that, however, cannot be used for various reasons. The countries and the reasons for the non-applicability of the models are listed in Table 3-2:

6 See Commerce Commission (2010). The normalized standard deviation of the benchmark set used by the NZ Commerce Commission is 0.355, while that of the present benchmark set is 0233.

Table 3-2: Models that could not be used

Country	Reason for non-applicability of model
France	Cost of termination cannot be computed according to the TSLRIC or comparable standard
Lithuania	Model is populated with dummy parameter values
Slovakia	Model is not populated with parameter values
Austria	Models are not in the public domain
Bahrain	
Belgium	
Germany	
Greece	
Israel	
Luxembourg	
Malaysia	
Turkey	

From Table 3-1 it appears that seven of the nine benchmark models are from member countries of the European Union. A criticism has already been levelled against this selection arguing that this “data set may contain correlated features that are driven by membership of the European Union and decisions that have been at EU level”. This criticism must be rebutted as irrelevant. First, while the European Commission specifies particular ground rules for determining rates for the termination of mobile services, these rules do not extend to prescribing the concrete approach to model construction. Second, something that we referred to above as the operation of unsystematic effects can be observed in the benchmark results, when one country (Denmark) shows a benchmark value of 1.779 AU cents and another (Portugal) one of 4.651 AU cents (after conversion into AU currency on the basis of a purchasing power parity adjusted exchange rate). When the rate of one country is more than double that of another country, it is hard to argue that they reflect some kind of correlated features.

4 Adjustments to the benchmarks for voice

Table 4-1 presents the benchmarks for the cost of voice termination as shown in the benchmark models. They are expressed in local currency and are those calculated for the year 2015. Note that due to the use of more recent models compared to those used for the previous version of the report, the cost figures for four countries have changed. In three cases (Denmark, Sweden, the UK), the changes were downwards, in one case (Portugal), the change was upwards.

Table 4-1: Original benchmark values

Benchmark country	Currency of benchmark country	Cost of voice termination for 2015 (nominal values)
Denmark	DK øre	7.949
Mexico	US cent	1.727
Netherlands	€ cent	1.844
Norway	NO øre	15.882
Portugal	€ cent	2.052
Romania	€ cent	1.166
Spain	€ cent	1.417
Sweden	SE öre	12.150
UK	pence	1.009

The following six sections will deal with the implementation of the adjustments according to the ToR and as commented on in Section 2. They are carried out in the following order:

(1) Conversion into Australian currency

(2) Step 1 of adjusting for spectrum fees: Elimination of the spectrum fees from the benchmark figures; spectrum fees applicable to the benchmark to reflect those in Australia to be added as a last step

(3) Adjusting for for differences in both network technology: Blending the costs of 2G/GSM and 3G/UMTS

(4) Adjusting for differences in the WACC

(5) Adjusting for differences in network usage

(6) Adjusting for differences in the cost of links in the backhaul network due to their greater average lengths in Australia

(7) Step 2 of adjusting for spectrum fees: Adding spectrums fees relevant for Australia

As will be remembered, some of the factors suggested by the ACCC are not represented in above list, i.e. “Geographic terrain”, “Population density”, “Scope of service” and “Spectrum allocation”. In Chapter 2 we argued that for determining the effect of the first factor there would be no robust standard regarding differences in geographic features and that the effect would in any case be very small; that the second is covered by “Network usage”; the third is covered by “Network technology”; and for the last one there exists no substantial reason to carry out an adjustment.

Except for the adjustments under (1), (2) and (6), which according to their logic come either at the beginning or at the end, the order of the adjustments is determined by the importance of the effects due to them. In the methodological note below, we show that the order in which these adjustments are carried out do not have any influence of the final outcome.

After having carried out the adjustments to obtain benchmarks for the year 2015, Section 4.8 then uses information regarding the future development of the cost of termination in order to derive benchmarks for the years 2016 through 2020.

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Methodological note

It must be shown that the order in which adjustments are carried out do not influence the result of the exercise.

Let

B_0 ≡ initial value of the benchmark of a country

B_1 ≡ value of the benchmark after 1st adjustment

B_2 ≡ value of the benchmark after 2nd adjustment

Δ_1 ≡ change in factor used for the 1st adjustment, exogenously given

Δ_2 ≡ change in factor used for the 2nd adjustment, exogenously given

$€_1$ ≡ elasticity with which the cost of the benchmark reacts to Δ_1, the change in the cost driving factor used for the 1st adjustment, exogenously given

$€_2$ ≡ elasticity with which the cost of the benchmark reacts to Δ_2, the change in the cost driving factor used for the 2nd adjustment, exogenously given

Then it holds that

(1) $B_1 = (1 + €_1\Delta_1)\, B_0$

(2) $B_2 = (1 + €_2\Delta_2)\, B_1$

Equation (1) represents the first adjustment, starting from B_0, and equation (2) the second one, starting from B_1, the result of the first adjustment. Now, by substituting the right side of the first equation into the second one, we obtain

(3) $B_2 = (1 + €_2\Delta_2)\ (1 + €_1\Delta_1)\ B_0$

By the rules of algebra, we can rewrite equation (3) in the form

(4) $B_2 = (1 + €_1\Delta_1)\ (1 + €_2\Delta_2)\ B_0$

which one would have obtained if the initially second adjustment is carried out first and the initially second one thereafter.

The above holds for all of the adjustments carried out. It follows that the order of performing the adjustments will have no influence on the final result. The reason is that the changes in the cost driving factors, and the elasticities with which the benchmarks are made to react to these changes, are all exogenously given.

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4.1 Conversion into Australian currency

The benchmarks are converted into Australian currency on the basis of a combination of (a) the relevant exchange rate of the Australian dollar to the foreign currency, and (b) this exchange rate adjusted to reflect differences in purchasing power parity (PPP). The PPP adjusted exchange rate is applied to account for the cost component due to those assets and activities that use local resources for which prices in the domestic market have to be paid. Australia is one of the most expensive countries in terms of PPP, so that the putting in place of network elements like towers and trenches and operating a mobile network is relatively more expensive there than in some of the benchmark countries, if the comparison is made using the nominal exchange rate. Using instead the PPP adjusted exchange rate for the corresponding portion of the benchmark cost compensates for the bias that otherwise would occur. We use weights of 50 % for each the nominal and the PPP-adjusted exchange rate.

This approach has been criticised by Network Strategies as not being consistent with best practice for currency conversion, for which either the exchange rate (if appropriate) or the PPP adjusted rate (if appropriate) should be used. For using a blend of the two, there would be no theoretical justification. In the methodlogical note below we rebut this criticism.

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Methodological note

We start with a brief descriptions of how the market exchange rate and the PPP rate are determined. The market exchange rate, as the name indicates, is determined on the foreign exchange market. Here, roughly, the demand for foreign currency by those who want to import goods and services and the supply of foreign currency by those who export goods and services brings about the rate at which a country's currency is exchanged against any particular foreign currency. It is true that this exchange rate is also influenced by capital movements, but in the long run it primarily reflects the country's terms of trade. This long-run aspect is captured in the present study by using the 10-year average of the exchange rates when expressing the benchmark countries' currencies in AUD.

The PPP in turn, quoting from the NWS submission, "is the ratio of a basket of goods in two countries each calculated in their own currency units. These costs reflect labour and other input costs, profit margins, indirect taxes and also, indirectly, capital costs. Hence in applying PPP rates we convert the benchmark rates to a common currency unit [say the Portuguese basket in terms of AUD], and at the same, adjust for average cost differences between countries." The last sentence implies that, if the law of one price were true, i.e. if relative prices were everywhere the same, and if there were no distortions due to taxation, inflationary forces and international capital movements, the market exchange rate and the PPP, disregarding in this simplified analysis transport cost, would be the same. This would be so, because if the law of one price holds, prices for traded goods from either country are the same, except of course for a multiplicative factor expressing the difference in the nominal dimensions of the currencies. Usually, however, the exchange rate and the PPP rate are not the same, because (a) the law of one price does not hold and (b) the basket of goods and services for which the PPP holds also contains those goods and services that are not traded. These non-traded goods include all labour-intensive retail services that, especially in low-income countries, make that these services enter the basket with relatively low prices. In our study this holds primarily for Mexico, Portugal and Romania. The PPP conversion factor for these countries' currencies relative to that for the AUD is therefore particularly high (see the table further below) which implies that there would have to be a large correction to make the prices of these services' comparable to those in Australia.

Note that the original objective of establishing PPP rates is to make diverse countries' national product estimates comparable. For this purpose it does not matter how the PPP rates for particular goods and services vary, as long as the basket is correctly specified, so that the resulting average PPP rates provide the correct basis for this comparison. In contrast, PPP rates have not been devised to allow converting the prices of particular goods or services from one currency into another one. This practice is so to speak a by-product of the availability of PPP rates and the need of converting prices of non-traded goods into another currency, especially when there are large differences in the underlying input prices. Actually, in order to convert the prices of particular goods or services, one would need individual PPP rates for these types of goods or services. In our study, this would have to be the specific PPP rates for mobile communications services, which however are not readily available.

Note, further, that blending the exchange rate and PPP rate with weights of X % for the exchange rate and (1-X) for the PPP adjusted rate is tantamount to devising a specific PPP rate applicable to the MTAS service, for which X % of the difference between the exchange rate and the nominal PPP rate is added to the exchange rate. For example, assume that X = 50 % and let the exchange rate be 2 and the PPP rate be 3. By adding together 50 % of 2 = 1 and 50 % of 3 = 1.5 one obtains 2.5 as the specific PPP rate, which corresponds to having added to the exchange rate of 2 a share of 50 % of the difference between that nominal PPP rate and the exchange rate. In this case the specific PPP rate would allow for 50 % of the mark-up that applies to the nominal PPP rate relative to the exchange rate. This is of course a rule-of-thumb approach, but one which reflects a precise understanding of the theory underlying exchange rate and PPP rate determination and appropriate judgment.

We indicated already at the beginning of this section that weights of 50 % are used for blending the two rates. Using these weights is conservative as the prices of labour and other non-traded inputs used for telecommunications networks are also in the low income countries closer to the corresponding ones in developed countries than to the prices of other typical non-traded goods and services. An indication for this is provided by the following observations.

One of the network elements that is to be considered as non-traded, and for which production on the basis of Australian cost levels is to be assumed, is the site for base stations. If in fact it enters in low income countries into the benchmarks at the low cost typical for these countries, then the adjustment of the benchmarks by high PPP adjusted rate would be justified. Now, since sites are network elements for which the investment values can be obtained from the benchmark models, a corresponding check can be carried out by comparing site investment values after conversion into AUD, with and without PPP adjustment. The expectation would be that if it is justified to convert the benchmark values for the cost of the MTAS at the PPP adjusted rate, then the investment values for sites, which enter as cost elements into the cost of the MTAS, should, when also converted at the PPP adjusted rates, be closer together than if converted at pure exchange rates. In particular in the low-income countries Mexico, Portugal and Romania, the erection of these sites would benefit from the low labour costs in these countries so that a conversion at PPP adjusted rates should even out the discrepancy.

The table below provides the relevant information.

Benchmark model for …	PPP relative to that of AUD	Investment for a site at …	
		… pure exchange rate	… 50/50 PPP adjusted exchange rate
Denmark	n/a since sites are rented		
Netherlands	1.455	212,579	*260,893*
Norway	1.000	181,579	*181,579*
Mexico	2.667	164,224	*301,076*
Portugal	2.000	133,154	*199,731*
Romania	3.200	184,553	*387,562*
Spain	1.778	151,439	*210,349*
Sweden	1.143	135,841	*145,544*
UK	1.455	163,711	*200,918*
Australia*	1.000	197,979	*197,979*
Average		*169,451*	*231,737*
Standard deviation		*27,113*	*73,702*

* Taken from the 2007 WIK model for the ACCC; value adjusted to 2015 price level.

Two things are to be noted:

(a) When the benchmarks are evaluated at the pure exchange rate, the values are more homogeneous than when they are converted at the PPP adjusted rate (compare the standard deviations).

(b) In particular the values for the models for the two countries with the highest PPP rate (Mexico and Romania), the PPP rate adjusted investment values are particularly out of range with the other ones.

From this follows that the assumption appears to be appropriate that for the sites in the benchmark models the values were set according to international market prices rather than, as initially expected, according to the cost levels of non-traded goods, which would have required an adjustment on the basis of the PPP rate.

It follows further that for a substantial part of the cost of the MTAS, for which initially it was thought that the PPP adjusted rate were required, this is not justified. This kind of conversion would then only be appropriate for the part of the network cost due to operating it (opex), and that at the specific PPP adjusted rate that is based on the cost of the more skilled labour used in operating networks.

To summarise, we propose to carry out the currency conversion in applying a blend of the pure exchange rates and the PPP adjusted exchange rates, where each is given a weight of 50 %. This we assume to be a conservative approach.

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As regards the inputs into the currency conversion exercise, the precise sources are provided as footnotes to Table 4-2 below in which the results are reported. As appropriate measure for the exchange rate, the average of the values over the past ten years is used, given that, as already mentioned, the current rates at any given moment of time reflect momentary world economic and financial conditions and are not necessarily reflective of the terms of trade holding between Australia and the benchmark countries. An average of the time series of this rate over a ten years period is a better indicator of the terms of trade than the current rate. To obtain the relevant PPP rates the exchange rates so derived are multiplied by the ratios of the PPP conversion factors to the USD market exchange rates that are made available by the World Bank as part of its world development indicators. Given that these conversion factors are relative to the US dollar, the benchmark countries' conversion factors are normalised relative to the one for Australia by dividing them by the factor applicable for Australia.

Table 4-2: Benchmark values in Australian currency

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Country	Benchmark in local currency	Exch. rate (10 year average)	PPP local currency / AUD	Exch. rate adjusted for PPP	Weighted average of exch. rate and PPP	Benchmark in AU cents	
						Exch. rate only	**PPP-adjusted exch. rate**
Denmark	7.949	0.209	1.143	0.239	0.224	1.660	1.779
Mexico	1.727	1.127	2.667	3.006	2.067	1.947	3.569
Netherlands	1.844	1.511	1.455	2.197	1.854	2.786	3.420
Norway	15.882	0.198	1.000	0.198	0.198	3.137	3.137
Portugal	2.052	1.511	2.000	3.022	2.266	3.101	4.651
Romania	1.166	1.511	3.200	4.834	3.173	1.762	3.699
Spain	1.417	1.511	1.778	2.686	2.098	2.141	2.973
Sweden	12.150	0.164	1.143	0.187	0.175	1.989	2.132
UK	1.009	1.895	1.455	2.757	2.326	1.912	2.346
					Average:	2.270	3.078

Sources: Reserve Bank of Australia (2015), for exchange rates for USD, EUR and GBP; XE (2015) for NOK, SEK and DKK.
World Bank (2015), Table 4.16 for the ratios of PPP conversion factors to USD market exchange rates.

Column (3) of Table 4-2 shows the ten year average of the exchange rate for the Australian dollar relative to each of the benchmark countries' currencies. Column (4) in turn indicates the relationship between the PPP indicator for Australia and that for the benchmark country, i.e. the factor by which the corresponding exchange rate must be multiplied in order to take account of the higher price level in Australia and thus for the higher prices of local resources used. The effect on the exchange rate is then shown in column (5) which is the product of (3) and (4). The 50/50 weighted average of the straight and PPP-adjusted exchange rates is shown in column (6) and the benchmark in Australian cents on the basis of this average is shown in column (8). Column (7) shows for comparison the value of the benchmark if the straight exchange rate were applied.

Despite toning down the effects of the PPP adjusted exchange rate by way of the 50/50 weighting, its application has a substantial effect on the benchmark values. This is obvious from the comparison of columns (7) and (8), in particular the average values shown at the bottom. We note that except for Norway, the PPP adjusted values are higher than the ones based on an unadjusted exchange rate, in some cases substantially. This for one confirms the observation made earlier that, when comparing local price levels with international ones, Australia is one of the more expensive countries in the world, but may also indicate that through the use of the PPP conversion factor there may be a degree of upward adjustment that goes beyond the differences in price levels and reflects the conservative approach applied in this study.

4.2 Adjusting for spectrum fees – Step 1

Spectrum fees vary substantially between the benchmark countries and therefore also in relation to those applicable in Australia. From this follows that adjustments will have to be carried out to make the benchmarks consistent with the corresponding cost level in Australia. In a first step, the approach consists in eliminating from the country benchmarks the components due to the spectrum fees; in a second step, carried out as the last adjustment to the benchmarks, the cost per minute that Australian operators on average incur on account of spectrum fees are added. This adjustment will be carried out in Section 4.6. Here the results of the first step are reported.

Note that eliminating the spectrum fees is the first adjustment after the currency conversion because, depending on the size of this fee, without its removal it would make the cost appear larger than the cost justified on the basis of the production relationships. The adjustments to be carried out in the following, however, represent in each case the impact of factors that work through such production relationships, so it is appropriate that the share in total cost due to spectrum fees be taken out before these adjustments are made.

Table 4-3 shows in the third column the benchmarks excluding the share of spectrum fees, while in the fourth column indicating the percentage that this fee made up in the original benchmark.

Table 4-3: Benchmarks without spectrum fees

(1)	(2)	(3)	(4)
Country	Original benchmarks in AU cents from Table 4-2	Benchmarks with spectrum fees eliminated	
		AU cents	Reduction
Denmark	1.779	1.677	6%
Mexico	3.569	3.112	13%
Netherlands	3.420	2.865	16%
Norway	3.137	2.959	6%
Portugal	4.651	4.406	5%
Romania	3.699	3.364	9%
Spain	2.973	2.777	7%
Sweden	2.132	2.129	0%
UK	2.346	2.042	13%
Averages:	3.078	2.815	9 %

Noting that the percentages due to the spectrum fees range between 0 % and 16 %, we observe that if they were not removed this would indeed introduce a bias in the subsequent adjustments. The impact is most visible in the difference between the averages of the original and the adjusted benchmarks, shown at the bottom of the table.

4.3 Blending the costs of 2G/GSM and 3G/UMTS

Since the adjustments in this section will be separately made on the cost figures for 2G and 3G, we present in Table 4-4 the benchmarks without spectrum fees separately for these two technologies.

Table 4-4: Benchmarks without spectrum fees for 2G and 3G

(1)	(2)	(3)
Country	Benchmarks with spectrum fees eliminated for	
	2G	3G
	AU cents	
Denmark	2.319	1.375
Mexico	4.150	2.474
Netherlands	3.448	2.216
Norway	5.137	1.567
Portugal	4.520	4.123
Romania	4.135	1.728
Spain	3.420	2.303
Sweden	3.086	1.341
UK	2.219	1.925
Average:	3.604	2.117

Note that the average for 2G lies above and the average for 3G below the average shown in Table 4-3 for the combined benchmark, which was to be expected, given that 3G is the more efficient technology.

The 2G and 3G technologies are used to substantially different degrees in Australia and in the models of the benchmark countries. Presumably spurred on by the relatively high use of data services, 3G technology is being used in Australia much more extensively and 2G correspondingly less. Since 3G is more efficient than 2G, adjusting the benchmarks to correspond to the Australian use of 2G and 3G will entail a decrease in the benchmarks. This is obviously so, because the lower per-minute cost of voice traffic carried by 3G will after adjustment be weighted by a higher share of traffic, and vice versa. This effect is still being increased by the fact that a much larger share of traffic, mostly data, is carried over 3G technology in Australia than in the benchmark models which makes for greater economies of scale, particularily in the radio access network, of which the provision of voice services also benefits.

A necessary input for carrying out the adjustments are the average shares with which voice is carried over the two technologies in Australia and in the benchmark countries.

Regarding the benchmark countries, this information is contained in the corresponding models. Regarding Australia, the ACCC obtained this information from the three operators. According to it, an average of 6 % of voice is carried over 2G and an average of 94 % over 3G. We considered these average shares to be the relevant ones for the hypothetical efficient operator in 2015 and thus will use them for the adjustments as shown in Tables 4-5 through 4-7.

The adjustments will be carried out in two steps. First, the benchmark models' costs for each technology will be adjusted to reflect the effect of greater economies of scale on cost in the case of traffic over 3G, and of lower economies of scale on cost in the case of traffic over 2G. The second step will then consist in calculating the weighted average of the new benchmark costs for 2G and 3G using the weights applicable to Australia. The results of the first step are separately produced for 2G and 3G in Table 4-5 and Table 4-6.

Important parameters for these adjustments are the elasticities with which the benchmarks react to changes in the share of the technology. An elasticity as used here expresses the fact that, if for example 2G technology is used for only 6 % of the volume instead of 71 %, then 2G facilities are used less intensively and diseconomies of scale become effective so that the per unit cost of providing the service over 2G increases. The opposite holds for the increase in the share of 3G. If for example 3G technology is used for 94% of the volume instead of 39 %, then 3G facilities are used more intensively and economies of scale become effective so that the per unit cost of providing the service over 3G decreases.

When in the previous version of this report we used an elasticity of -0.5 for determining the *increase* in the costs of delivering service over 2G due to the reduction in the use of this technology and an elasticity of -0.3 for determining the *decrease* in the cost of delivering service over 3G due to the increase in the use of this technology, this has been criticised by the operators in their submissions. The criticisms are not in agreement with each other, for example with Vodafone claiming a lower elasticity for both 2G and 3G while Optus claiming a higher elasticity for 2G and a lower one for 3G. In the following methodological note we revisit this issue arguing that there are good reasons to apply elasticity values that essentially confirm the initially used ones of -0.5 and -0.3. The argument will rest on simulations with the WIK model that in particular take into account the effect of using 3G technology for a volume of services comparable to the average one in the Australian networks and thus substantially higher than that carried in the benchmark networks.

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Methodological note

The WIK model used for the analysis is a further development of the model developed 2006/2007 for the ACCC. It is now a generic multi-technology model that encompasses the currently used 2G, 3G and 4G technologies and is used for many different environments. One of its features, as was the case for the original model for ACCC, is its flexibility in that, starting from information regarding subscribers' demand and this demand's distribution over the territory to be covered, applying engineering principles and using information regarding input prices, a network can be developed without that information from operators is necessarily required. Also one of its features is that varying degrees of employment of the different technologies, differentiated according to the types of demand for which they are to be used, can be implemented on the basis of parameters that are specified by the user.

The concrete specification of the model underlying the present analysis is for a network with the following features:

- It accommodates demand for 2G voice and data services, 3G voice and data services, and 4G data services.
- Input prices and other cost parameters are from the WIK data bank and are consistent with those found in the typical cost model that are in the public domain.
- More than 90 % of traffic is accounted for by data services.
- It comprises between 17,000 and 18,500 sites, depending on the level of demand and the types of technology combinations employed.

In the opening scenario, average annual network usage is about 4,700 GB per site, which corresponds approximately to the average network usage observed in the benchmark models. In the high volume scenario, network usasge is about 15,000 GB per site, which is comparable to that observed on average in the Australian networks.

- The following scenarios are calculated:

  (a) 48 % of voice traffic is carried over 2G, the rest over 3G. These shares correspond to the average of the technology shares applied in the benchmark models. Total volume of traffic corresponds to an annual network usage of 4,700 GB per site, which again corresponds to the average in the benchmark models.

  (b) 6 % of voice traffic is carried – as in Australia – over 2G, the rest over

3G. Otherwise as above.

(c) As (b) but total volume of traffic corresponds to an annual network usage of 15,000 GB per site.

The focus is on the percentage changes in the cost of the termination when there is a shift from a 48 % share of voice over 2G to a 6 % share, and then when there is a shift from an annual volume of traffic of 4,700 GB per site to one of 15,000 GB per site. The table below shows the results.

Scenario shift	Change in cost
Shift from a 48 % share of 2G traffic to one of 6 %	-52 %
Increase in volume of traffic from 4700 GB to 15,000 GB per site and annum	-63 %

We observe that the shift in technologies appears to entail the larger cost decrease, more than halving the level while the three-times increase in volume brings about an additional decrease of 11 %. We are of course cognizant of the fact that the above values are results of a model that may not be applicable across all network environments. The insight it provides into the differential impacts on cost when there is simultaneously a substantial shift in the degrees with which 2G and 3G technologies are used and a large increase in the volume of traffic can, however, be considered as generally applicable. It is plausible that the cost decrease due to the technology shift is the larger one because this change impinges directly on the production of voice. In contrast, the change in volumes, primarily due to data services, impinges on voice indirectly in that the fixed cost of 3G facilities are being spread over a greater volume than before.

We believe that providing above detail regarding these relationships is helpful in the present context, as it allows to substantiate the approach that we are to propose for adjusting the technology shifts on the one hand and the increases in volume, i.e. the increase in network usage, on the other hand. We consider the percentage cost changes obtained on the basis of the simulations with the WIK model as the upper limit of the ones that would result from corresponding changes in the benchmark models. We will therefore select an elasticity value for the differences in technology shares that leads to a cost decrease of -37 %, which equals two thirds of the value of -52 % obtained with the WIK model, thereby maintaining the principle of a conservative approach. Similarly, to account for the effect of larger volumes, the elasticity values will be chosen to lead to a decrease in cost of two thirds of the value of -11 % shown above for the WIK model. The elacticity values needed for determining the cost decreases due to the differences in technology are -0.55 for the 2G shift and -0.22 for the 3G shift, which are a bit more conservative than the ones used for the previous report. The elasticity value for arriving at the cost decrease due to the differences in network usage is with 0.022 slightly less conservative than originally.

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Turning to the derivation of results in Tables 4-5 and 4-6, we observe that column (2) shows each time the starting benchmarks values, as already known from Table 4-4, and column (7) shows each time the resulting change in the benchmark. In column (3) the models share of the technology is indicated, in column (4) the one for Australia, in column (5) the percentage difference in that share as shown in the model and holding for Australia, in column (6) the value of the elasticity applied. We note that on average the increase in the per minute cost of 2G technology is higher than the decrease in the cost of 3G, reflecting the effect of cost reactions at different ends of the scale of utilisation discussed in the methodological note.

Table 4-5: Adjusting 2G benchmarks for the share of 2G in Australia

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	Benchmark with spectrum fees eliminated (AU cents)	Original 2G share in model	2G share in AU	Percentage difference in share in the model vs. AU	Elasticity with which 2G costs react to technology share	Change in benchmark due to difference in 2G share (AU cents)
Denmark	2.319	32%	6%	-81%	-0.55	1.036
Mexico	4.150	38%	6%	-84%	-0.55	1.922
Netherlands	3.448	53%	6%	-89%	-0.55	1.681
Norway	5.137	39%	6%	-85%	-0.55	2.391
Portugal	4.520	71%	6%	-92%	-0.55	2.277
Romania	4.135	68%	6%	-91%	-0.55	2.073
Spain	3.420	42%	6%	-86%	-0.55	1.615
Sweden	3.086	45%	6%	-87%	-0.55	1.472
UK	2.219	40%	6%	-85%	-0.55	1.036
					Average:	+1.723

Table 4-6: Adjusting 3G benchmarks for the higher share of 3G technology as well as the higher volume of traffic over this technology in Australia

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	Benchmark with spectrum fees eliminated (AU cents)	Original 3G share in model	3G share in AU	Percentage difference in share in models vs. AU	Elasticity with which 3G costs react to technology share	Change in benchmark due to difference in 3G share (AU cents)
Denmark	1.375	68%	94%	38%	-0.22	-0.116
Mexico	2.474	62%	94%	52%	-0.22	-0.282
Netherlands	2.216	47%	94%	99%	-0.22	-0.481
Norway	1.567	61%	94%	54%	-0.22	-0.186
Portugal	4.123	29%	94%	229%	-0.22	-2.079
Romania	1.728	32%	94%	194%	-0.22	-0.736
Spain	2.303	58%	94%	63%	-0.22	-0.320
Sweden	1.341	55%	94%	71%	-0.22	-0.211
UK	1.925	60%	94%	56%	-0.22	-0.237
					Average:	-0.516

Note the algebraic signs in Tables 4-5 and 4-6, indicating – as was to be expected from the methodological note – that the changes for 2G benchmarks have gone up, due to lower economies of scale by shifting to a 6 % share, and that the changes for 3G benchmarks have decreased, due to this time greater economies of scale by shifting to a 94 % share. In Table 4-7, the changes in the 2G and 3G cost figures, shown in Tables 4-5 and 4-6, are added to those which we started with at the beginning of this adjustment. The old values are shown in columns (2) and (3) and the newly adjusted ones in columns (6) and (7). The newly blended results, based on weights of 6% for GSM and 94 % for UMTS, are shown in column (8).

Table 4-7: Deriving blended 2G/3G benchmarks based on adjusted benchmarks from Tables 4-5 and 4-6

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Country	Benchmark before the adjustment for …		Change in benchmark due to difference in share of ...		Adjusted benchmark for …		New blended 2G/3G bench-mark
	2G	3G	2G	3G	2G	3G	
Denmark	2.319	1.375	1.036	-0.116	3.355	1.259	1.385
Mexico	4.150	2.474	1.922	-0.282	6.072	2.192	2.425
Netherlands	3.448	2.216	1.681	-0.481	5.129	1.735	1.939
Norway	5.137	1.567	2.391	-0.186	7.528	1.380	1.749
Portugal	4.520	4.123	2.277	-2.079	6.797	2.044	2.329
Romania	4.135	1.728	2.073	-0.736	6.208	0.992	1.305
Spain	3.420	2.303	1.615	-0.320	5.035	1.983	2.166
Sweden	3.086	1.341	1.472	-0.211	4.557	1.131	1.336
UK	2.219	1.925	1.036	-0.237	3.255	1.688	1.782
				Average:	5.326	1.601	1.824

Note that the average of the blended result decreased from 2.815 AU cents, shown at the bottom of Table 4-3, to a value of 1.824 AU cents. This is a decrease of 35 % which should be compared with the 52 % decrease from the simulation with the WIK model. As discussed in the methodological note, we consider the decrease obtained with the WIK model as an upper limit and used elasticity values for the changes in 2G and 3G costs to achieve here an overall decrease of 35 %, which, to be on the conservative side, corresponds to two thirds of the value from the WIK model. Note, too, that the elasticities of -0.55 and -0.22 are close to the ones that were originally used to support our results in the previous version of the report.

4.4 Adjusting for differences in the WACC

We are advised by the ACCC that the WACC applicable to mobile network operators in Australia is 5.89 %. The values of the WACC applied in the benchmark models vary between 4.60 % and 12.95 %. Given that the WAAC directly affects annualised capex, the most important primary cost component of a telecommunications network, there is a clear need for adjustments of the country benchmarks.

The procedure is similar to the one applied in the preceding section for the adjustments due to differences in the use of 2G and 3G technologies. First, for each benchmark country, the percentage difference between its WACC level and that for Australia is determined. Then an average elasticity with which the cost of termination reacts to changes in the level of the WACC is applied to determine the impact on the cost. Of the empirically observed range of elasticities we select a conservatively low value of 0.2. Here we rely for one on the results reported in the study for the New Zealand Commerce Commission in which we reported elasticities that show the reaction of costs to changes in the WACC,[7] further on more recent results from simulations with the WIK model (already referred to in the methodological note regarding elasiticty values).

The impact will be negative if the difference between the Australian WACC and that of the benchmark country is negative, which is the case across all benchmarks apart from one. The resulting changes will then be added to the levels of the so far adjusted benchmarks (as derived in the preceding section). The several steps are represented in Table 4-8.

Table 4-8: Adjustments for differences in the WACC

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Country	WACC in Bench-mark countries	WACC in AU	Percent-age difference in level of WACC	Elasticity of reaction of cost to WACC	Percent-age change in bench-mark	Change in bench-mark	Adjusted benchmark (AU cents)
Denmark	4.60%	5.89%	28%	0.2	6%	0.078	1.463
Mexico	12.95%	5.89%	-55%	0.2	-11%	-0.264	2.160
Netherlands	6.60%	5.89%	-11%	0.2	-2%	-0.042	1.897
Norway	11.28%	5.89%	-48%	0.2	-10%	-0.167	1.582
Portugal	10.68%	5.89%	-45%	0.2	-9%	-0.209	2.120
Romania	11.10%	5.89%	-47%	0.2	-9%	-0.123	1.183
Spain	10.87%	5.89%	-46%	0.2	-9%	-0.199	1.968
Sweden	7.61%	5.89%	-23%	0.2	-5%	-0.060	1.276
UK	8.93%	5.89%	-34%	0.2	-7%	-0.121	1.660
					Averages:	-0.123	1.701

Column (2) shows the different levels of the WACC in the benchmark countries, column (4) the percentage differences between those levels and that of Australia. In column (6), the percentage change in the benchmark by applying the elasticity of 0.2 is indicated and in column (7) the corresponding change in the benchmark applied to the values shown in Table 4-7 as result of the preceding adjustment. Finally, column (8) presents the resulting benchmark after this adjustment. By comparing the average shown at the bottom of Table 4-8 with the average shown in Table 4-7, this adjustment has led to an average decrease of the benchmark of 0.123 AU cents, i.e. from 1.824 AU cents to 1.701 AU cents.

7 See WIK-Consult (2008).

4.5 Adjusting for differences in network usage

We have discussed this factor already in Section 2.5, where we showed that the network usage of operators in Australia, according to the information reported by them, is substantially larger than that in any of the benchmark models. We pointed out that on the basis of these differences in the degrees of network usage, the argument that because of Australia's population density costs should be higher in Australia is not valid. On the contrary, given the high network usage shown for Australian networks relative to that in the benchmark models, the per unit cost of services in Australia must be considered to be substantially lower than that in the models. It was thus pointed out that on account of the relatively low network usages shown by the models, the benchmarks needed to be adjusted downward to reflect the cost that would hold if corresponding network usage degrees had been implemented in these models.

The lower cost of the voice and therefore termination service due to a higher degree of network usage follows from the following relationships. The large network usage shown for Australian networks is primarily due to the large growth in the demand for data services to an extent that by now – measured in a common dimension, i.e. gigabyte – they make up about 98 % of total traffic. From this expansion in the demand for data services benefit voice services in so far as their share of the costs of commonly used facilities (sites of base stations and controllers, links for conveyance of traffic between nodes) gets smaller, as a larger and larger share of these costs are being now borne by data services. That lower costs of the voice and therefore termination services follow from such higher degrees of network usage was demonstrated in the above methodological note regarding elasiticities. We derived there a value of the elasticity of 0.022 which leads to a decrease in the cost of 7 %. This we showed to be a conservative value compared with a cost decrease of 11 % due to a comparable increase in network usage implemented in simulations with the WIK model.

Before actually carrying out the adjustments, we take up comments in the submissions by Optus and Vodafone regarding the inclusion of 4G traffic in the measure of network usage in the Australian networks and refute them in the following methodological note.

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Methodological note:

Optus[8] and Vodafone[9] propose to exclude 4G traffic to characterize network usage in Australia and claim that its inclusion in WIK-Consult's adjustment calculations to be an error. Both operators argue that some of the benchmark models do not include 4G traffic. Therefore it would be distortive or even misleading to include it in the Australian case.

8 See Optus (2015), pp 275 ff.
9 See Vodafone (2015) pp. 18 ff.

Hybrid 2G/3G/4G networks share the resources of most network elements of a mobile network. Accordingly, to handle the significant amount of 4G data traffic, as is the case in Australia, the capacity of the former 2G/3G networks e.g. in terms of number of sites and capacity of backhaul and core links had to be increased. Following proper cost accounting principles, bottom up cost models allocate the cost of shared resources in a network according to the capacity requirements and relative usage of the services. The implementation of 4G data services has therefore an proportionate impact on the cost of providing voice services over the 2G and 3G network, because major elements of the network used for 2G/3G services are now shared in also providing 4G data services. Disregarding the 4G traffic would therefore overestimate the cost of the voice termination in Australia. In other words, Optus' and Vodafone's proposal would even imply that the users of 2G and 3G services should cover the cost of providing 4G data services.

Mobile network cost models may exclude 4G data traffic for two reasons: Firstly, operators do not apply 4G technology yet in that particular country. Or, secondly, the amount of 4G traffic is still low in the relevant period, so that regulators ignore it in their termination cost calculation. In these cases, there might be a point in questioning whether the modeled networks correspond to efficient networks, given current standards. However, if the benchmark cost models which (currently) do not include 4G data traffic were to include 4G traffic, which usually means that total traffic increases, they would generate lower voice termination costs. In these (hypothetical) cases, their traffic volumes would be shown to be higher than currently and an adjustment to account for the differences with Australia would be less, but that from lower levels of cost and lead to results that are consistent with the ones arrived at from the currently shown lower traffic and higher cost levels.

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The adjustments are carried out in Table 4-9. As in respect of the parameter differences handled in the preceding two sections, first the degrees of network usage (in terms of volume per site) for the benchmark models and for Australia are presented in columns (2) and (3), then the percentage differences in column (4) are shown. Applying to them the elasticity of 0.022 with which the costs are made to react to them, the results presented in columns (6) and (7) are obtained.

Table 4-9: Adjustments for differences in network usage

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	Network usage in terms of GB per site in …		Percentage difference relative to usage in AU	Elasticity of reaction of cost to degree of network usage	Change in benchmark	Adjusted benchmark
	Models	Australia				
Denmark	9,944	15,569	-57%	0.022	-0.018	1.445
Mexico	5,102	15,569	-205%	0.022	-0.098	2.063
Netherlands	1,838	15,569	-747%	0.022	-0.312	1.585
Norway	3,429	15,569	-354%	0.022	-0.123	1.459
Portugal	4,441	15,569	-251%	0.022	-0.117	2.003
Romania	1,323	15,569	-1077%	0.022	-0.280	0.903
Spain	6,014	15,569	-159%	0.022	-0.069	1.899
Sweden	8,779	15,569	-77%	0.022	-0.022	1.254
UK	8,990	15,569	-73%	0.022	-0.027	1.634
				Average:	-0.118	1.583

Comparing the average shown at the bottom Table 4-9 with the average benchmark resulting from the preceding adjustment in Table 4-8, we observe an average decrease of the benchmark of 0.118 AU cents, i.e. from 1.701 AU cents to 1.583 AU cents. This is a 7 % decrease and corresponds the one derived in the methodological note regarding the determination of elasticity values for technology changes.

4.6 Adjusting for differences in the cost of backhaul distances

In the previous version of this report, no adjustment was made on account of the backhaul distances. The reason was that while there are such differences between the Australian networks and those in the benchmark countries, it was considered that the resulting higher cost are essentially compensated by the cost decreases realised through transmissions systems of high capacity that in the Australian networks could be used given the substantially larger volumes there compared to those in the benchmark networks. There are sources, according to which the cost of transmission systems increases as a function of the capacity raised to a power that is between 0.4 and 0.5, which makes that per-km cost are much lower for high capacity than for capacity links.[10] As regards the dependence of the cost of transmission systems on distance, the link cost used in the WIK 2007 model for the ACCC showed a marked cost degression as a function of distance, where the corresponding information had been obtained from the operators.[11]

10 For example, if the price of a 64 kps system is 229 and that of a 155 mps system is 5687, then the latter price can be regarded as the result from the following equation: $P_{155mps} = 229*(155{,}000/64)^{0.412}$, see TRPC (2010). See also Minoux (1974) and Kleinwillinghöfer (1981).

11 See WIK-Consult, WIK Mobile Network Cost Model (2007), Mask "Cost Parameters", File "Cost Parameter File", Rider "Link investment". There it is shown that the per-km cost of a local line was then

In the spirit of a conservative approach to this benchmark cost determination, and considering that despite the above there remains some merit to the argument that due to the distances in Australia, that are huge relative to the ones in the benchmark countries, operators there potentially face higher cost for backhaul links, we have taken up the proposal in one of the operators' submissions to increase the benchmarks by an across-the-board mark-up of 3 %. This is implemented in Table 4-10.

Table 4-10: Adjustments for differences in backhaul distances

Country	Benchmark after preceding adjustment	Percentage change due to greater backhaul distances in Australia	Benchmark after current adjustment
Denmark	1.445	3%	1.488
Mexico	2.063	3%	2.125
Netherlands	1.585	3%	1.633
Norway	1.459	3%	1.502
Portugal	2.003	3%	2.063
Romania	0.903	3%	0.930
Spain	1.899	3%	1.956
Sweden	1.254	3%	1.292
UK	1.634	3%	1.683
Average:	1.583		1.630

4.7 Adjusting for spectrum fees – Step 2

In Section 4.2 we had eliminated from the benchmarks the local spectrum fees, varying substantially from one country to the other, in order to be able to make unbiased adjustments for the production-related parameter differences. As last adjustment to the 2015 benchmarks, the values emerging from the preceding round of adjustments need now to be marked-up for the share of spectrum fees due to termination that are relevant for Australia.

The first step in this process is the determination of the annual amount of spectrum fees paid on average by the Australian operators for the various spectrum bands. We present in Table 4-11 the corresponding derivation. We abstain from deriving the average capacities in the various spectrum bands that would devolve to the hypothetical efficient operator. We showed in Section 2.6 that the available spectrum would not constrain the design of the radio access network for the delivery of voice and SMS services, and that therefore the benchmarks need not be adjusted on account of the

7 % of that of a long-distance line. While the absolute cost figures may have changed since then, the cost degression effect will most probably still be effective as it was then.

availability of spectrum. From this follows that we do not need to know the quantities of spectrum that the hypothetical efficient operator would have.

Column (2) of Table 4-11 shows the average amount paid by the operators at auctions for each of the various spectrum bands (except for the 900 MHz band, see below); columns (3) and (4) indicate the values of the parameters “WACC” and “Period of assignment", column (5) the annuity formula to transform an one-off payment into an annuity, and column (6) the corresponding annual amount for each spectrum band. The entries for the 900 MHz band differ as for this band there is no one-off payment, but there are annual payments that, averaged here over the three operators, are shown in column (6). Turning to the lower part of the table, we observe in line (a) the sum of expenses for all spectrum bands. In line (b) we add 2 % for opex. In this respect, we differ from the benchmark models and also from the WIK model for the ACCC in 2006/07, where no opex on account of spectrum is recognised. In our opinion, the control of proper use of spectrum requires some expense that justifies the inclusion of a mark-up for opex.[12] In line (c) a common cost, put at 10 % of the subtotal in line (c) is added, where this mark-up is an experience value based on WIK’s knowledge of other cost models and operators’ cost accounting records. The entry in line (e) represents the total amount paid for spectrum by the hypothetical efficient operator in Australia.

12 Opex are expenses to keep assets in working condition. There is no question that opex arises for facilities like base stations and transmission systems. Opex has typically not been taken into account for spectrum, although it is without question also an asset for which opex arises due to its administration and the control over its proper use. While we deem that a value of 10 % of the investment value, which is the experience opex value for the hardware assets, must be considered as too high, we believe that an “over the thumb” estimate of 2 % would be appropriate.

Table 4-11: Derivation of total cost of spectrum for the hypothetical efficient operator

<table>
<tr><th>(1)</th><th>(2)</th><th>(3)</th><th>(4)</th><th>(5)</th><th>(6)</th></tr>
<tr><th>Band</th><th>Amount paid in AUD (average over 3 AU operators)</th><th>Period of assign-ment in years</th><th>WACC</th><th>Formula for annuity A</th><th>Annuity</th></tr>
<tr><td>700/2500 MHZ</td><td>975,576,701</td><td rowspan="5">15</td><td rowspan="5">5.89 %</td><td rowspan="5">$A = \frac{5.89\,\%}{\left[1 - \left(\frac{1}{1 + 5.89\%}\right)^{15}\right]}$</td><td>100,102,284</td></tr>
<tr><td>800 MHZ</td><td>586,884,568</td><td>59,022,580</td></tr>
<tr><td>1800 MHz</td><td>150,149,949</td><td>16,762,540</td></tr>
<tr><td>2000 MHz</td><td>386,514,500</td><td>57,101,241</td></tr>
<tr><td>2300 MHz</td><td>21,287,615</td><td>2,205,010</td></tr>
<tr><td>900 MHz</td><td colspan="4">Determined on the basis of annual payments, shown here as average for the 3 operators; implied capitalisation on basis of the investment/annuity relation for the other frequencies: 266,099,904</td><td>27,201,801</td></tr>
<tr><td>(a)</td><td colspan="4">Sum of annuities based on amounts paid for spectrum plus expenses for 900 MHz band:</td><td>262,395,457</td></tr>
<tr><td>(b)</td><td colspan="4">Opex = 2 % of total investment in spectrum (see column (2), including the capitalised expenses for 900 MHZ):</td><td>51,337,340</td></tr>
<tr><td>(c)</td><td colspan="4">Subtotal:</td><td>313,732,797</td></tr>
<tr><td>(d)</td><td colspan="4">Common cost = 10 % of subtotal:</td><td>31,373,280</td></tr>
<tr><td>(e)</td><td colspan="4">Total:</td><td>345,106,077</td></tr>
</table>

Source: ACCC for amounts paid by operators, the WACC, period of assignment

The next step consists in deriving a measure of the volume of traffic for each service and for the total traffic, deemed to be carried by the hypothetical efficient operator in Australia in 2015. This volume will be expressed in gigabytes (GB), the measure for data, the predominant part of traffic. Before presenting in Table 4-12 the in GB transformed volumes of voice and SMS, we show in the methodological note, how this transformation is carried out.

****

<u>Methodological note</u>

For transforming minutes of voice into gigabytes (GB), we proceed as follows:

- We assume the bitrate for voice to be 12.2 kbit/s.
- The conversion factor for GB into kbit is 8,388,608, arrived at by multiplying the number of bits in one byte, which is 8, by the number of kbits in 1 gigabit, which is 1,024*1,024.
- Let V be the volume of voice in minutes
- The first step is the transformation of minutes into seconds which leads to V*60.
- Next the volume in seconds is multiplied by the bitrate of voice to obtain the volume of voice in kbits, which leads to V*60*12.2 kbit.
- The result of the preceding step is divided by the conversion factor between GB and kbit arrived at above, ie. 8,388,608.
- The result is the desired volume of voice expressed in the dimension of GB.

For transforming the number of SMS into GB, we proceed as follows:

- We assume an SMS size of 140 bytes (including overhead)
- Let Q be the number of SMS.
- The conversion factor between GB and byte is 1,073,741,824, arrived at by recognising that 1 kbyte has 1,024 bytes and 1 megabyte has 1,024 kbytes and 1 gigabyte has 1,024 megabytes.
- The transformation consists in multiplying Q by the SMS size to obtain volume of SMS in bytes i.e. Q*140.
- Next the volume in bytes is divided by the conversion factor shown above of 1,073,741,824.
- The result is the desired volume of the number of SMS expressed in the dimension of GB.

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Table 4-12: Total traffic of hypothetical efficient operator measured in GB and shares of the three different services of voice, SMS and data

Service	Volume in 2014 of traffic in …		Projected growth rate	Forecast traffic volumes in GB for 2015	Shares
	Original units	in GB			
Voice	30,226,567,092 minutes	2,637,607	5%	2,769,487	1.639%
SMS	15,974,697,159 m	2,083	4%	2,166	0.001%
Data	118,710,269 GB	118,710,269	40%*	166,194,377	98.360%
			Total:	168,966,030	100.000%

* The projected growth rates are based on the three operators' average growth rates for 2013/2014, all slightly scaled down to allow for some possible slackening of growth.

Source: ACCC for volumes of traffic and, derived from them, projected growth rates.

From Table 4-12 follows that 1.6 % of the annual cost of spectrum is to be borne by voice services. In Table 4-13 we derive the corresponding mark-up that needs to be added to the model benchmarks to make them comparable with the corresponding cost figure in Australia.

Table 4-13: Determination of per minute mark-up for spectrum fees

Object of consideration	Unit	Relevant quantity
Total cost of spectrum	AUD	345,106,077
Share assigned to voice	%	1.64
Fees assigned to voice	AUD	5,656,561
Volume of voice projected for 2015	minutes	31,737,895,446
Spectrum fee per minute of voice	AU cents	0.018

We are now in a position to carry out the last adjustment to the 2015 benchmarks. Table 4-14 shows in column (2) the benchmarks derived after the preceding round of adjustments, in column (3) the amount to be added for spectrum fees and in column (4) the resulting benchmark including spectrum fees as relevant for Australia.

Table 4-14: Adding a mark-up for Australian spectrum fees to the benchmarks

(1)	(2)	(3)	(4)
Country	Benchmark after preceding adjustment	Mark-up for spectrum	Benchmark after current adjustment
	AU cents		
Denmark	1.488	0.018	1.506
Mexico	2.125	0.018	2.143
Netherlands	1.633	0.018	1.651
Norway	1.502	0.018	1.520
Portugal	2.063	0.018	2.081
Romania	0.930	0.018	0.947
Spain	1.956	0.018	1.974
Sweden	1.292	0.018	1.310
UK	1.683	0.018	1.701
Average:	1.630		1.648

The mark-up for expenses of spectrum is with 0.018 AU cents per minute, and therefore about 1 % of the average of the benchmarks, in the low range of that observed in the benchmark models. Also, it makes up less than 10 % of the amount in the cost estimate obtained in the 2006/2007 modelling exercise. Nevertheless, there is no doubt that this value is still conservative. The reasons are as follows:

- Within the various frequency bands, spectrum can now be used for any of the relevant services, in particular for data services which have actually become the greatest devourer of spectrum resources. This already implies that the cost of spectrum should be allocated to per unit cost of each service on the basis of a common mark-up.
- As we know from our discussion in Section 4.3, only a share of 6 % of the volume of voice is currently still being carried by 2G technology, the technology for which spectrum in the 900 and 1800 MHz band is used. In these bands, operators are actively re-farming spectrum from the use for 2G to the use for 3G and 4G.[13] Much of the re-farmed spectrum is used for data services. Also, the concurrent shift of voice volume from 2G to 3G technology implies a more efficient use of spectrum for voice by a factor of approximately two. Both observations points to the circumstance that a relatively small share of the spectrum in these bands is still being used for voice and SMS.
- The total cost of spectrum (bottom line of Table 4-11) is allocated to the various services on the basis of the shares in total traffic. The alternative approach would be to allocate the cost of the 900 and 1800 MHz bands according to the relative uses of

13 See Whirlpool (2015).

this spectrum by these services. This calculation is, however, not possible, since the relative uses for these bands are not known. By the approach actually used, voice is getting a larger share of cost allocated to it than would be the case if the alternative approach could be applied, because the amounts per MHz that were paid for the other bands were higher than for the 900 MHz and 1800 MHz bands.

4.8 Three statistics for expressing the expected central value from the set of adjusted benchmarks

The adjustments reported in the preceding section brought us to the final country benchmarks for 2015, the average of which is 1.65 AU cents. While the average (mean) is the most often used statistic for expressing the expected value of a common characteristic of a given data set, it is not necessarily the least biased one. Other candidates that statistically are preferable are the mean with extreme values removed and the median. Extreme values can often be traced to inappropriate underlying assumptions or other mistakes in the process creating them, and depending on their weight may then strongly bias the mean upwards or downwards, which would be the justification for removing them. The median, i.e. the value that lies precisely in the middle, with as many values above and as many values below, is not subject to the influence of any extreme values and can therefore be considered as the least biased one; if there are deviations, however, they may also be in any direction. We show the three statistics for our set of adjusted benchmarks in Table 4-15.

Table 4-15: Means and median of adjusted benchmarks

Statistic	Value (AU cents)
Mean (average)	1.65
Mean with extreme values removed	1.68
Median	1.65

In our case, the mean with extreme values eliminated is higher than the mean of the whole data set, because the lower extreme value is farther away from the mean than the upper extreme, The median, in turn, is equal to the mean, from which it appears that the individual benchmark values are rather symmetrically distributed around their central moments. In Section 6 we will recommend the average benchmark with extreme values removed as the cost for the year 2015.

Having thus revised our benchmark study, taking on board advice from the ACCC as well as criticisms and suggestions in the submissions of the operators, we note that the results for an estimate of the cost of voice termination are not very different from the ones we obtained in the first version of this report. This does not mean that there have not been changes in the process of doing the revision, there were quite a number of them. It so happened that these changes tended to even out, given that some were downward and others were upward. Since most of the changes are due to suggestions and proposals that were submitted by the operators, it is noteworthy that these interventions not only aimed at increasing the cost estimates but also led to decreases relative to the estimates presented in the previous version of the report.

According to the ToR we are to provide advice and recommendations on a cost range that reflects our view on the cost of providing voice termination service in Australia. The derivation of this cost range recommendation in Chapter 6 will be based on the mean with extreme values removed. Its advantage vis-à-vis the other preferred statistic, i.e. the median, is that it has a well defined second moment, the standard deviation, which will be useful in defining the relevant cost range. It is also the more conservative one.

4.9 Benchmarks for the years 2016 through 2020

Beside determining the benchmark value for the cost of terminating a call in 2015, WIK-Consult's brief consists also in deriving corresponding benchmarks for the years 2016 through 2020. For this we are advised by the ACCC that it is expected that voice over 4G will become a reality in Australia, and it is therefore necessary to factor into the forecasts for these future years the effect on cost of the use of this most recent technology, which in relation to UMTS will again represent a substantial improvement in efficiency and therefore entail a decrease in cost.

In the previous version of the report we could base our anlaysis solely on the benchmark model for the UK, since it was the only one showing the cost of termination for these years with part of voice traffic having been realised over 4G technology, The selection of benchmark models used for the present version of the report includes the model for Portugal as another one that also that bases the cost of termination for the years after 2015 on a partial employment of 4G technology. These are here the two models with benchmarks for the years 2016 through 2020 showing the effect of lower cost due to this technology. The yearly overall percentage decreases in cost (both due to 4G as well as due to general cost decreases) are for the two countries shown in columns (2) and (3) of Table 4-16, and their average decreases in column (4). An obvious approach to deriving a forecast of the future level of the cost of termination is to use the cumulative rate of 26.8 % (which happens to be same value arrived at in the previous version of the report on the basis of old UK model) and apply it to the benchmark for 2015 to arrive at a value for 2020 and then interpolate values on a linear basis to obtain values for the intervening years. In Table 4-16 is shown that proceeding this way we arrive for the year 2020 at a value of 1.23 AU cents.

Table 4-16: Cost trends in the UK and Portugal models for 2016– 2020 applied to the benchmark for 2015

(1)	(2)	(3)	(4)	(5)
Year	Changes in benchmark			Benchmarks for years 2015 through 2020 according to average trend shown in column (4)
	UK	Portugal	Average	
2015				1.68
2016	-8.4%	-3.5%	-6.0%	1.59
2017	-5.2%	-5.6%	-5.4%	1.50
2018	-6.8%	-5.6%	-6.2%	1.41
2019	-8.9%	-4.6%	-6.7%	1.32
2020	-8.6%	-3.4%	-6.0%	1.23
Compound rate:	-32.6%	-20.7%	-26.8%	1.23

Further information regarding the role of voice over 4G in the UK model is presented in Tables 4-17. We observe that the shares of voice being carried during the years 2016 through 2020 over 4G, as an average over the two models, rises from 2 % to 29 % and that the relation of the cost of voice over 4G to that of voice over 3G is on average 0.41. We use this information for another approach to determining the forecast of the cost of termination in 2020.

Table 4-17: Production relationships regarding voice over 4G in the UK and Portugal models

Year	Share of voice being carried over 4G			Relation of the cost for 4G to that of UMTS		
	UK	Portugal	Average	UK	Portugal	Average
2016	0%	4%	2%	33%	47%	40%
2017	3%	13%	8%	34%	46%	40%
2018	9%	22%	16%	36%	46%	41%
2019	17%	30%	24%	38%	46%	42%
2020	23%	36%	29%	41%	46%	43%
					Average:	41%

The approach is presented in Table 4-18 and discussed in the following.

Table 4-18: Benchmark for the cost in 2020 based on the component costs of 3G and 4G

No.	Object of consideration	Unit	Relevant quantity
(1)	Average of the cost of carrying termination over UMTS as shown on the bottom of column (7) of Table 4-7 (before adjustments for the differences in WACC, network usage, cost in backhaul network, spectrum fees)	AU cents	1.60
(2)	Cost of carrying termination over UMTS after application of the same adjustments (from Table 4-7 onwards) as for the blended benchmark*, §	AU cents	1.45
(3)	Relation of cost of voice over 4G to that over 3G on the basis of the relation shown in the UK and Portugal models	cents/cents	0.41
(4)	Derive cost of voice over 4G accordingly	AU cents	0.59
(5)	Average share of voice over 4 G in UK and Portugal models in 2020	minutes/minutes	0.29
(6)	Blend 3G cost and 4G cost according to the weights of those in the UK model	AU cents	1.20

* We leave the level of this cost as that for 2015 on the assumption that general decreases in cost for using 3G technology due to less expensive equipment is cancelled through the diseconomies of scale of lower volumes being provided over this technology.

§ This is the average of the 3G cost for the set benchmarks with extreme results removed.

In line (1) we start with the average cost of providing termination using 3G technology. The value in line (2) has undergone the same adjustments (for differences in the WACC and differences in backhaul network cost) as were applied to the blended cost of 2G and 3G. These two values are thus based on information from all benchmark models. Line (3) shows the relation between the cost of delivery of voice over 4G to that of 3G in the UK and Portugal models, which in line (4) is applied to the value in line (2) to obtain an estimate of the cost of providing termination service over 4G. This value is 0.56 AU cents. Line (5) then shows the share of 4G in the provision of termination in 2020 in the UK and Portugal models, which we interpret here to mean in respect of Australia that the remaining 71 % are delivered over 3G, the technology of 2G not being used anymore by Australian operators. Blending the 3G and 4G costs using the just mentioned two percentages as weights leads to an estimate of the cost of termination in 2020 of 1.204 AU cents which must be compared with 1.23 AU cents in Table 4-16 that we obtained by applying the yearly averaged cost decreases shown in the UK and Portugal models.

From a methodological point of view, the second approach is the one to be preferred, as it is based on clear productive relationships: estimates of the cost per minute delivered over 3G and 4G plus shares with which termination is provided over these two technologies. As disadvantage may be considered that it needs more assumptions for deriving the components making up the estimate than needed for the first approach, for which the only assumption is that due to the impact of also using 4G in the next five years there will be annual decrease in the cost of about 6 % on average. Nevertheless the two approaches lead to similar results, where however that from the first approach is more conservative. We will therefore base our recommendation for the benchmarks for the years 2016 through 2020 in Chapter 6 on this latter value.

5 Derivation of a benchmark for the cost of SMS

According to the ToR, WIK-Consult is requested to advise the ACCC on whether it is feasible to determine the cost of an SMS in relation to the cost of the capacity of one minute of voice call, i.e. on the basis of a conversion factor. In the paragraphs below we show that this is the logical way to determine the cost for the conveyance part of the cost of an SMS. To this cost component must, however, be added the cost of special equipment that is dedicated to the handling of SMS messages, which, because it is dedicated, is not included in the benchmark for voice and must therefore be determined in a separate calculation. It turns out that this is the more important component of the cost of an SMS.

As regards the first conveyance part of SMS cost, this concerns the cost due to the carriage of SMS messages through the network, from the radio access network to the server locations in the core network, and vice versa. For this conveyance service, the same network elements are used for the conveyance of SMS as are used for the conveyance of voice traffic. Furthermore, the capacity used for the conveyance of one SMS stands in a fixed relation to the capacity used for one minute of voice. From this follows that the cost of one SMS message can be determined by multiplying the cost of one minute of voice by a fixed conversion factor. The derivation of the benchmark for the conveyance of SMS messages according to this approach is shown in Table 5-1.

Table 5-1: Derivation of the benchmark for the conveyance of SMS messages

Object of consideration	Unit	Applies to …	
		2G	3G
Channel rate of the two technologies used for SMS	bits/s	6,144	16,000
Multiplication by 60	bits/minute	368,640	960,000
Division by 8	bytes/minute	46,080	120,000
Length of one SMS	bytes	140	140
Capacity in number of SMS per minute of voice call	number/minute	329	857
Blended according to 6 % 2G and 94 % 3G	number/minute	825	
Conversion factor	minute/number	0.00121	
Cost per minute of termination of voice (from Table 4-15, mean value with extreme results removed)	AU cents / minute	1.68	
Cost per SMS	AU cents / 1 SMS	0.0020	

When considering the numbers in Table 5-1, and in particular the low cost of conveyance per SMS that result from them, it should nevertheless be noted that this result is still conservative in the sense that the assumed length of 140 bytes for one SMS is the maximum length that such a message can take, and that if a more realistic lower figure were used the number of possible messages per minute would be larger and the cost per message correspondingly lower. It is further to be noted that the total capacity needed for the SMS service altogether is so small in relation to the capacity needed for voice (see Table 4-12), that it can be presumed that this capacity is never explicitly considered when planning the network, and is in fact being provided out of spare and/or signalling capacity, which means that the cost of making this capacity available is actually zero. This holds in particular also, because SMS messages have low priority and can in the busy hour be delayed if there were capacity constraints. There may be the rare instance where capacity made available for SMS messages impair the quality of services of the other services (voice and data) which would then be the justification for also assigning a cost component for the conveyance part of the service. It should, however, not be considered to be higher than the cost shown in Table 5-1.

The second cost component for the termination of SMS messages is due to the SMS centres (SMSCs), the dedicated equipment needed for handling the messages through the network. Although only one of the benchmark models indicates a TSLRIC+ cost figure for SMS messages, all models include in their overall calculations the cost of SMSCs. In Table 5-2: we pick up the investment shown in these models for an SMSC as well as the number of such centres, and use this information as basis for arriving at our own benchmark for this cost component.

Table 5-2: Investment into SMS centres in the benchmark models

Country	Investment into one SMSC	Number of SMSCs in the network
Denmark	330,920	3
Mexico	2,930,945	2
Netherlands	2,788,014	2
Norway	4,255,727	1
Portugal	2,381,992	2
Romania	1,041,527	2
Spain	854,998	2
Sweden	1,395,360	4
UK	5,229,858	3
Average:	2,356,593	2.33

Given the (anticipated) heterogeneity of the investment figures as revealed in Table 5-2, and in the expectation that more precise information could be obtained from the Australian operators, we asked the ACCC early in the course of the study to request the operators to provide that information as it applies to their networks. It appeared from their responses that they were not in a position to provide information in the form as presented in the models and shown in Table 5-2. Some information was provided, but for confidentiality reasons we refrain from describing it in any detail, except to point out that, if converted into a suitable form, it would probably result on average in a higher investment figure than the average shown in Table 5-2. Further to mention that the figures provided appear to also include investments, like for development of the service, that are needed for retail activities, which would not be applicable to be included here. As a consequence of this situation, we rely on information from the benchmark models, using, however, for “investment” and for “number of SMSCs” figures from the upper ranges in the table which means that we are deriving a conservative benchmark. The corresponding calculation is provided in Table 5-3.

Table 5-3: Derivation of the benchmark for the SMS centres

Object of consideration	Unit	Relevant quantity
Investment per SMS centre	AUD	5,000,000
Number of SMS centres	Number	3
Total investment	AUD	15,000,000
WACC	%	5.89
Length of economic life of SMSC	years	8
Annuity (formula as in Table 4-11)	AUD	2,405,034
Opex = 10 % of investment	AUD	1,500,000
Subtotal of annuity and opex	AUD	3,905,034
Common cost = 10 % of subtotal	AUD	390,503
Total cost of SMSCs	AUD	4,295,537
Number of SMSs	Number	16,613,685,045
Cost per SMS	AU cents	0.0259

* The rate of 10 % on the investment value for opex as well as the 10 % mark-up for common cost are experience values that WIK knows from the analysis of cost accounting records of actual operators. We also applied these rates in the 2006/07 cost model for the ACCC.

In Table 5-4 we add the two cost components from Table 5-1 and Table 5-3 together.

Table 5-4: Benchmark cost per SMS

Cost component	AU cent per SMS
Cost due to conveyance	0.002
Cost due to SMS centres	0.026
Total cost per SMS	0.028

As appears from the above derivation, the bulk of the cost of providing SMS services is due to the dedicated equipment needed to handling them. Based on information from the benchmark models, we have made conservative assumptions for deriving the cost of these centres. Altogether, the two components lead to a cost for terminating one SMS that is lower than three hundredth of one AU cent. We obtained a similar result in the study carried out for the ACCC in 2006/2007.

The very low benchmark for terminating an SMS, which are presumably magnitudes below commercially negotiated rates in Australia,[14] needs further comment. These are in particular also called for, given that the benchmark in the one benchmark model that also shows the cost of terminating an SMS, i.e. the Denmark model, is with about 1 øre, or about 0.25 AU cents, still more than eight times higher than the cost arrived at here. Also the range of benchmarks between 0.06 and 0.48 NZ cents in the 2011 determination of the New Zealand Commerce Commission is substantially higher than the one obtained here. The same is true for the range of benchmarks reported in the ACCC's discussion paper of August 2014, where the range is between 0.04 AU cents and 1.74 AU cents, the lowest value of 0.04 AU cents being that for India.[15] The higher cost in the Danish case is primarily due to a – in our view – disproportionate cost for wholesale overhead. This cost component amounts, as determined by the Denmark model, to more than half of the cost of terminating an SMS. We are at a loss in identifying the type of wholesale activities that on account of terminating SMS traffic would generate such a relatively high cost. The provision of termination services does not require wholesale activities of the usual kind, since they are brought to one's points of interconnection unsolicited. There is no question that there is billing and some degree of customer care to assure frictionless interfaces with the interconnection partners at the SMS centres, but this type of cost is covered by the opex and common cost components included in the cost of these facilities. Our – not exhaustive – search for statements of regulatory agencies explicitly facing the very low cost of terminating SMS services led to the 2010 determination by the Communications Commission of Kenya, who recognises a pure LRIC cost for terminating an SMS of less than KES 0.01 or about 0.02 AU cents (taking PPP into consideration).[16] Given that pure LRIC costs tend to be half that of LRAIC costs, this would imply a cost of about 0.04 AU cents, which, beside the benchmark from India noted above, comes close to the benchmark obtained in this study. On the basis of these observations, we have no reason to question our above result simply because it is so much lower than most other benchmarks.

14 See Australian Competition & Consumer Commission (2014). In the table shown on page 10 of this document, the highest of seven benchmarks for SMS termination rates is shown to be 1.74 AU cents. The then following comment states that the regulated termination rates in the table are significantly lower than the current commercially negotiated SMS termination rates in Australia.

15 See Australian Competition & Consumer Commission (2014).

16 See Communications Commission of Kenya (2010).

6 Advice and recommendations

The ToR require us to provide advice and recommendations on

- a cost range that reflects the estimated costs of providing the mobile voice termination service in Australia, and
- whether, how and with what adjustments it is feasible to base SMS termination rate relative to the mobile voice termination rate

Below we present our recommendations which are based on the results of our analyses carried out in Chapters 4 and 5.

6.1 Cost range for the mobile voice termination service in Australia

Our recommendation regarding the range of costs for the termination of voice derive from the results presented in Table 4-16 summarising our analyses carried out in Chapter 4. The recommended range for this service is based on the average benchmark with extreme values removed, i.e. 1.68 AU cents for the year 2015 and 1.23 AU cents for the year 2020, the values for the years in between having been linearly interpolated. The standard deviation around the 2015 value is 0.27 AU cents or 16 %. Following statistical practice, we define the cost range around the selected mean values on the basis of this standard deviation. The results are presented in Table 6-1.

Table 6-1: Recommended cost ranges for the termination of voice for the years 2015 - 2020

(1)	(2)	(3)	(3)
Year	Limit of lower range	Benchmark values for the years 2015 - 2020	Limit of upper range
	AU cents		
2015	1.41	1.68	1.95
2016	1.34	1.59	1.84
2017	1.26	1.50	1.74
2018	1.18	1.41	1.64
2019	1.11	1.32	1.53
2020	1.04	1.23	1.44

According to our analysis, we believe that the cost for terminating voice on the network of an efficient hypothetical operator in Australia lies within the ranges shown in Table 6-1. When assessing these ranges, the reader should take into consideration that we derived the benchmarks in column (3) of the table always with the concern in mind to be conservative rather than progressive, in particular when carrying out the adjustments.

6.2 Approach to determining the cost of terminating SMS

In Chapter 5 we demonstrated that the cost of conveyance of an SMS over the network can straightforwardly be derived from the cost of a minute of voice termination, using a conversion factor that is based on the relative capacity requirements of the two services. It was, however, also shown that there is a second component in the cost of SMS termination, i.e. the cost of the dedicated SMS centres necessary to handle the SMS on the network, which is actually the more important of the two components.

We derived cost estimates for both cost components, in the one case based on the conversion factor corresponding to the relative capacity requirements, and in the other case based on information regarding the expenses for SMS centres, for which benchmarks from the benchmark models were used. The resulting, conservatively derived, cost per SMS, as shown in Table 5-4, is 0.028 AU cent (in words: 2.8 hundredth of one AU cent) per SMS.

As this cost estimate is presumably below commercially negotiated rates by magnitudes, we then engaged in a discussion to the effect that there are no reasons to doubt the level of the cost that we derived. Our advice to the ACCC is therefore to seriously consider that the cost of terminating an SMS on the network of an efficient hypothetical operator in Australia corresponds to the one referred to in the preceding paragraph.

Appendix Links to benchmark models

Country	Year of development	Link
Denmark	2015	https://erhvervsstyrelsen.dk/afgoerelser-2014-0
Mexico	2015	http://www.ift.org.mx/iftweb/industria-2/unidad-de-prospectiva-y-regulacion/modelo-de-costos-utilizado-para-determinar-las-tarifas-de-interconexion-aplicables-al-ano-2015/
Netherlands	2013	https://www.acm.nl/nl/publicaties/publicatie/11645/Notificatie-ontwerpbesluit-marktanalyse-vaste-en-mobiele-gespreksafgifte-2013-2015/
Norway	2013	http://eng.nkom.no/market/market-regulation-smp/cost-model/lric-for-mobile-networks
Portugal	2015	http://www.anacom.pt/render.jsp?contentId=1354357&languageId=1#.VbiBUtLtlBd
Romania	2013	http://www.ancom.org.ro/en/lric-2011-2013_4348
Spain	2012	http://www.cnmc.es/es-es/telecomunicacionesysaudiovisuales/regulaci%C3%B3n/an%C3%A1lisisdemercados/an%C3%A1lisisdemercados-revisi%C3%B3n2013.aspx
Sweden	2015	http://www.pts.se/sv/Bransch/Telefoni/Konkurrensreglering-SMP/SMP---Prisreglering/Kalkylarbete-mobilnat/Gallande-prisreglering/
United Kingdom	2015	http://stakeholders.ofcom.org.uk/consultations/mobile-call-termination-14/

References

Australian Competition & Consumer Commission (2015): Website - Mobile terminating access service FAD inquiry 2014, consulted: 3 February 2015, https://www.accc.gov.au/regulated-infrastructure/communications/mobile-services/mobile-terminating-access-service-fad-inquiry-2014/consultation-on-primary-price-terms-conditions-pricing-approaches.

Australian Competition & Consumer Commission (2014): Mobile terminating access service, Final access determination discussion paper, August 2014.

Australian Competition & Consumer Commission (2011): Inquiry to make a final access determination the Domestic Mobile Terminating Access Service (MTAS) – Access Determination Explanatory Statement, 7 December 2011.

CIA (2015): The World Factbook, downloaded: 6 March 2015, https://www.cia.gov/library/publications/the-world-factbook/fields/2125.html.

Commerce Commission (2010): Final Report on whether the mobile termination access services (incorporating mobile-to-mobile voice termination, fixed-to-mobile termination and short-message-service termination) should become designated or specified services, 22 February 2010.

Commerce Commission (2011): Standard Terms Determination for the designated services of the mobile termination access services (MTAS) fixed-to-mobile voice (FTM); mobile-to-mobile voice (MTM) and short messaging services (SMS), 5 May 2011.

Network Strategies (2015): Benchmarking Mobile Termination Access Service in Australia, Review of the methodology, Final report for Telstra, 5 June 2015.

Optus (2015), Mobile Terminating Access Service – Final Access Determination, Submission in response to ACCC Draft Decision, June 2015.

Reserve Bank of Australia (2015): Historical Data - Exchange Rates – Monthly – July 1969 to December 2009 & January 2010 to latest comple moth of current year, downloaded: 6 February 2015, http://www.rba.gov.au/statistics/historical-data.html.

Telstra (2015), Response to the ACCC's Mobile Terminating Access Service final access determination – Draft Decision, 15 June 2015.

Vodafone (2015), MTAS Access Determination: Draft Decision, Submission to the Australian Competition and Consumer Commission, June 2015.

WIK-Consult (2008), Cost Driver Sensitivity Analyses with Mobile Cost Models, Study for the New Zealand Commerce Commission, 22 December 2008.

WIK-Consult (2007), Mobile Termination Cost Model for Australia, Report for the ACCC, January.

World Bank (2015): Data – Urban population 2013, downloaded: 16 March 2015, http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS.

World Bank (2015): World Development Indicators: Exchange rates and prices, downloaded: 17 March 2015, http://wdi.worldbank.org/table/4.16.

Whirlpool (2015); Australian Mobile Network Frequencies, downloaded: 19 March 2015, http://whirlpool.net.au/wiki/mobile_phone_frequencies.

XE (2015): XE Currency Charts, downloaded: 6 February 2015, http://www.xe.com/currencycharts/.

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